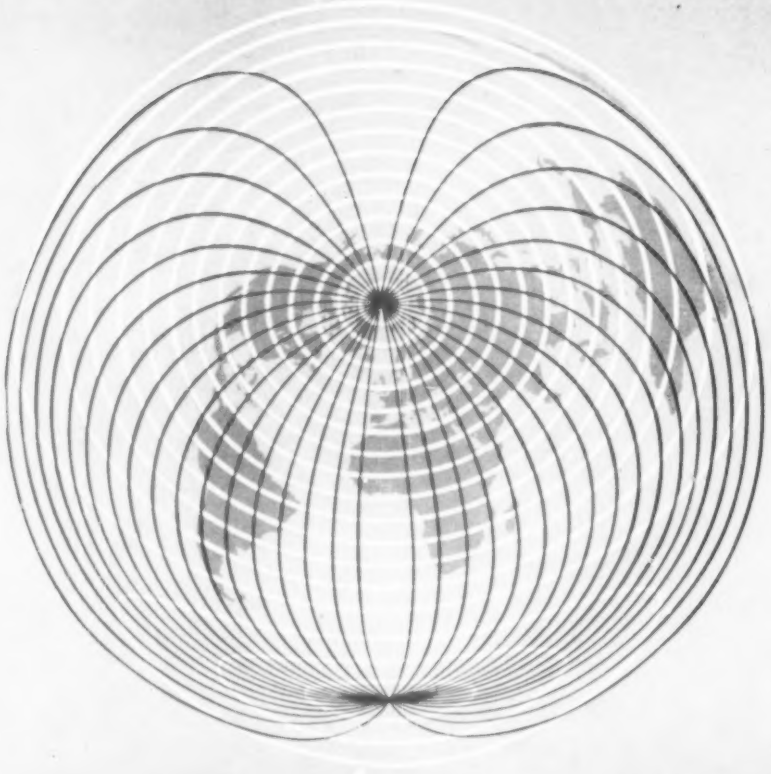
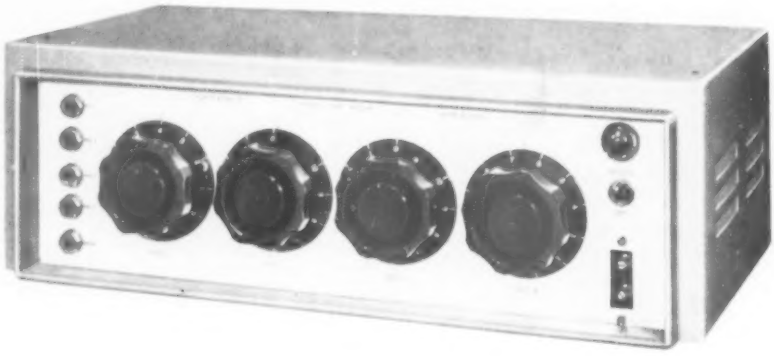
Wireless World

JANUARY 1952 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

FOUR-WAY ELECTRONIC MIXER



This unit has 4 built-in, balanced and screened microphone transformers, normally of 15-30 ohms impedance. It has 5 valves and selenium rectifier supplied by its own built-in screened power pack: consumption, 20 watts.

Suitable for recording and dubbing or large P.A. installations since it will drive up to six of our 50 watt amplifiers, whose base dimensions it matches. The standard model has an output impedance of 20,000 ohms or less and any impedance can be supplied to order.

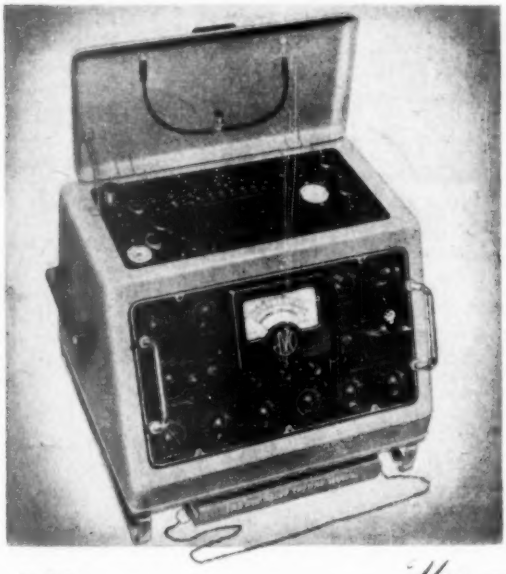
Manufactured by:

VORTEXION LIMITED

257-263 THE BROADWAY WIMBLEDON
LONDON S W 19

Telephones: LIBerty 2814 & 6242-3 *Telegrams: "Vortexion, Wimble, London."*

WHEN YOU THINK OF A VALVE TESTER..



What do you expect ?

The answer is, of course, not to think of a Valve Tester when you can have so much more. Here is a precision measuring instrument that will not only give a quick good bad verdict on **any** receiving valve, small transmitting valves, thyratrons, etc., but will also provide the electronic engineer and designer with accurate facts about any valve **under working conditions.**

12 GOOD REASONS for the success of The AVO Valve CHARACTERISTIC Meter

Price £50

Complete with quick-reference Data Manual containing data covering more than 3,000 British, American and Continental valves, plus approximately 1,200 Service equivalents.

Plus **FREE INFORMATION SERVICE**

The completion and return of the registration card within the Manual will bring you from time to time additional data which has been set out in such a manner that it can be inserted in the Manual in correct alphabetical and numerical sequence.

1. Whilst its features make it invaluable for the **skilled** radio and television engineer, it can be used as a reliable good/bad indicator by any **unskilled** operator of normal intelligence.
2. It is more than an emission tester . . . it enables the slope of a multi-electrode valve to be checked at any point between 0 and − 100 V. on the control grid.
3. A special form of polarised relay is incorporated to give protection against inadvertant overloads or valve failure.
4. With the exception of a small diode, there are no internal electronic components to deteriorate or break down and so cause misleading readings. Thus no expensive periodical replacements are required.
5. The comprehensive Data Book supplied free with the instrument facilitates the rapid checking of over 3,000 different types of valve. The instrument can be used, however, with complete accuracy by employing any other data available, thus bringing obsolete and experimental valves within its scope.
6. It enables Ia/Va, Ia/Vg, Ia/Vs, etc., characteristics to be plotted.
7. It detects grid current **and** indicates its direction and magnitude.
8. It measures inter-electrode insulation in rotation with valves cold or not, also cathode heater insulation with the valve hot and indicates any breakdown below 10 megohms.
9. Rectifiers and Signal Diodes can be subjected to maximum operating load.
10. It subjects the valve under test to working voltages.
11. It will carry out tests on small thyratrons, tuning indicators, etc.
12. It is fitted with bases for **all valves in current use** and adaptors will be available to keep the instrument fully up to date as new bases come into use.

Write for fully descriptive pamphlet, or for complete catalogue of all "Avo" Instruments.

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD.
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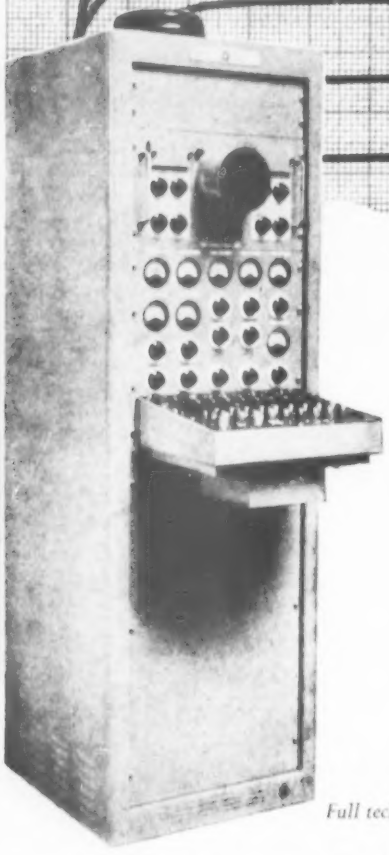
VC.4

11—Ia/Va CURVES in 1/50th OF A SECOND!



—with the

'CINTEL' UNIVERSAL VALVE TESTER

This instrument will produce a family of eleven Anode Current/Anode Voltage curves on a cathode-ray tube screen and is suitable for testing any receiving type valve. A calibrated graticule enables direct comparison to be made with valve manufacturers' published curves and the optimum operating conditions for a valve in any circuit are easily obtained.

Full technical information is available on application to:—

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A Company within the J. Arthur Rank Organisation

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CINTEL

REGISTERED TRADE MARK

HIGH EFFICIENCY AT V.H.F. with this new MULLARD DOUBLE TETRODE

The new Mullard double-tetrode, QQV06-40, is designed for wide-band operation as an R.F. Amplifier, Modulator, or Frequency Doubler and Tripler.

An improved version of the American 829B, the QQV06-40 has the outstanding advantage of very small output capacitances which permit its use at frequencies up to 500 Mc/s. In addition, the comparatively low inter-electrode inductance of this valve, obtained by the use of a common box screen grid, enables it to operate at V.H.F. with a higher stability than has yet been attained by valves in this class.

When used in tuned-anode, tuned-grid transmitters, the stability of this double-tetrode is increased even further by the use of internal neutralizing condensers.

Other important design features are:—

1. Direct and short connections between pins and electrodes, causing lower inductance and resistance.
2. No insulating parts (mica or ceramics) between anodes, resulting in lower losses at V.H.F.
3. Screened micas, preventing possible losses due to contaminated mica.

Brief technical information on the QQV06-40 is given here. Full information on this and other valves in the Mullard range will be supplied on request to the address below.

HEATER

	Series	Parallel
V_h	12.6	6.3 V
I_h	0.9	1.8 A

CAPACITANCES

Each section

$C_{g1\text{-}all}$	10.5 μμF
$C_{a\text{-}all}$	3.2 μμF
$C_{a\text{-}g1}$	<0.08 μμF

Two sections in push-pull

C_{out}	2.1 μμF
C_{in}	6.7 μμF

LIMITING VALUES

V_a max.	600 V
p_a max.	2 x 20 W
V_{g2} max.	250 V
p_{g2} max.	2 x 3 W
V_{g1} max.	−175 V
p_{g1} max.	2 x 1 W
I_k max.	2 x 120 mA
f max. (at reduced ratings)	486 Mc/s

BASE: B7A

Mullard

MULLARD LTD · COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT
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The finest range of Reproducing and Recording Equipment on attractive terms

The BSR 3-SPEED GRAMOPHONE UNIT. Type GU4

with High Fidelity Lightweight Crystal Head

- 33⅓-45-78 r.p.m. speeds by switching.
- 4 pole induction motor.
- Transcription quality.
- Automatic stop.
- 10in. heavy pressed steel turntable fitted with removable rubber mat.

BSR 3-Speed RECORD PLAYER. Type PD/GU4

- The type GU4 unit mounted in solid portable rexine case with all leads.
- Transcription quality.

£19.5.6 CASH, or £5 deposit and 12 monthly payments of 28/-.

£9.19.11 CASH, or Deposit **£2.10.0** and 12 monthly payments of 16/-

BSR 3-SPEED GRAMOPHONE UNIT. Type MU14

£6.8.6 CASH, or **£1.9.0** deposit and 12 monthly payments of 11/6.

- 33⅓-45-78 r.p.m. speeds by switching.
- 4-pole induction motor.
- 10in. heavy pressed turntable.
- Ideal for use with any pick-up.
- No stray field radiation.
- No belts employed.

BSR De Luxe Gramophone Unit. Type MU15

- Available in either 33⅓ or 78 r.p.m.
- 8in. diameter turntable.
- Ideal for portable record player.
- For use where space is a consideration.
- Ideal for use with any pick-up.
- Net weight 2 lbs.

£3.0.0 CASH, or 10/- deposit and 12 monthly payments of 7/6

BSR SHADED POLE INDUCTION MOTOR. Type TP1

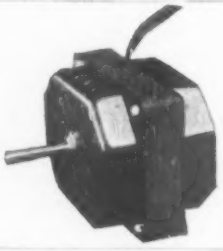
- 2,900 r.p.m.
- Mains consumption 10-15 watts.
- 200-250 v. 50 c/s AC.
- Weight 1lb.
- Ideal for gramophone motors models toys etc.

22/-

BSR 4-POLE INDUCTION MOTOR. Type FP10

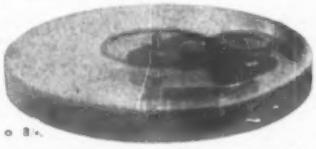
- Negligible external magnetic field.
- Constant speed and silent running.
- Ideal for recorders. Capstan drive.
- 1,400 r.p.m.
- Torque 3 inch ozs.
- Weight 1¼lb.
- 100/125-200/250 v. 50 c/s AC.

38/-



BSR 2-Speed GRAMOPHONE UNIT. Type MU10

- 33⅓ or 78 r.p.m. by reversing drive pulley.
- 10in. heavy pressed steel turntable.
- Ideal for use with any pick-up.

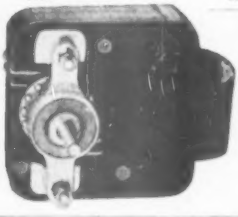


£3.18.7 CASH or £1 deposit and 12 monthly payments of 8/-.

BSR 2-Pole INDUCTION MOTOR. Type 8R1

- 2,750 r.p.m.
- Full load torque 3in. ozs.
- Weight 2¼ lbs.
- Will stand heavy overloads.
- 230 v. 50 c/s AC.
- Ideal for gramophones, motors, fans, switch movements recorders etc.

32/-



BSR 2-Pole INDUCTION MOTOR. Type 8R2 **25/-**

- 2,750 r.p.m.
- Full load Torque 2in. ozs.
- Weight 1¼lb.
- 230 v. 50 c/s AC.
- Ideal for motion displays timing mechanisms, recorders, etc.

Special Offer of **COLLARO AC 3/514 GRAMOPHONE UNITS**

A 3-speed non-auto unit already mounted on wooden mounting plate fitted with matching transformer, needle cup, spare head holder. Complete with extra head. Only **£1..6.5**

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FOR SUPERIOR PERFORMANCE AT LOWER COST !

★ Totally enclosed with Tape Guide. ★ Wide Frequency Range.
★ High Impedance. ★ Half Track Width. ★ Positive Fixing Method.

Record Playback or Erase Head

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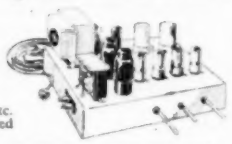
The M·O·S ·QUALITY GRAND· AMPLIFIER

A 7-VALVE PUSH-PULL AMPLIFIER EXPRESSLY DESIGNED for the CONNOISSEUR

Complete in kit form with all valves and components, pre-drilled chassis, down to nuts, bolts and solder, etc. Supplied with comprehensive illustrated construction manual.



- Frequency Response 0.5db 30 c/s—12 kc/s.
- Distortion 0.45 per cent total at 1,000 c/s for 8 watts.
- Maximum power output, type A, 10w., type B, 14w.
- High gain input.
- Low gain input.
- Bass boost cut.
- Treble boost cut.
- Negligible phase shift.
- 20 db Negative feed back.
- 3, 7.5, and 15 ohm outputs
- Neg. feed back loop incorporates output transformer, p.p. output stage, phase inverter and driver.
- For A.C. mains.

Type A 8 Watt Output H.P. terms: £3 deposit and 12 monthly payments of 15/-. Instruction manual only 4/6, post free. **£9.19.6** complete, carriage paid.

Type B 12 Watt Output H.P. terms: 20/- deposit and 12 monthly payments of 16/8. Instruction manual common to type A, 4/6. **£11.5.0** complete carriage paid.

RECOMMENDED SPEAKERS for the 'QUALITY GRAND' series of AMPLIFIERS

WHARFEDALE	Cash	H.P. Deposit	12 monthly payments of
W.10 CSB	£8 10 0	£2 10 0	13 4
Golden CSB	£5 7 6	£1 17 6	9 2
Golden	£4 17 6	—	—
Super SCS AL	£4 12 6	—	—
Bronze 10in. 15Ω or 3Ω	£3 2 6	—	—
Super SCS	£4 7 6	—	—
Bronze 8in.	£2 6 6	—	—

GOODMANS	Cash	H.P. Deposit	12 monthly payments of
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Audiom 60	£8 12 6	£2 12 6	13 4

STENTORIAN			
Concentric Duplex with transformer	£7 15 0	£2 5 0	12 6

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Distributors for the
"LANE" TAPE TABLE

Take up and fast re-wind control

Erase head | Capstan |
Record playback head Pinch roller

- ★ A precision built table at an extremely competitive price.
- ★ Heavy flywheel.
- ★ Fast rewind.
- ★ Tape Speed 7½ ins./sec.
- ★ Circuit diagram included.

£16.10 (Carr., pkg., 10/-). Deposit of £6 10/- and 12 monthly payments of £1.

LANE OSCILLATOR UNIT
Constructed on a small chassis and providing variable r.f. for bias and erase. Output is ample to erase the most difficult signals from modern tapes and each unit is checked for waveform.
OC.1. Erase and bias generator unit Complete with valve. **£3.10.0**
Deposit 10/- and 12 monthly payments of 8/4.

OC.2 OSCILLATOR COILS.
As used in OC.1 r.f. generator. For use with high or low impedance heads. **10/-** each.

HEADS
Audigraph "TAMSA" Record/Playback Erase, or Playback only **£2 19 6** each.

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	Cash	Dep.	12 monthly payments of
Acos Mic 22-2	£6 6 0	26/-	10 10
Acos Mic 16-2	£12 12 0	42/-	16 8
Reslo Ribbon	£7 10 0	50/-	11 8
Grampian M.C.	£5 17 6	40/-	9 10

The M.O.S MAGNETIC RECORDING RECORD/PLAYBACK AMPLIFIER Type A4

Designed for use with high impedance record/playback heads this amplifier solves the circuitry problems of the home constructor In the "Record" position the amplifier has provision for microphone and gramophone inputs. A mixer circuit allows fading and balancing between these two inputs during recording if so desired. A radio feeder may be used in place of the gramophone. In the "Record" position provision is also made for monitoring on headphones the material being recorded. The use of headphones eliminates feedback problems usually associated with speaker monitoring.
In the "Playback" position the circuit is re-arranged to form a stable very high gain amplifier. Pre-set equaliser circuits are included with a certain amount of further tonal adjustment given by a variable tone control. The use of a low hum, low noise pentode in the first stage gives a very good signal to noise ratio on playback. The microphone circuit is terminated in an impedance satisfactory for most crystal microphones, the Acos MIC 22-2 being particularly recommended. The playback pre-amplifier stage uses an EF37A (OM58B) giving extremely high signal to noise ratio, complete freedom from microphony and negligible hum.

FEATURES

1. Two input circuits on "Record."
2. Mixing between inputs.
3. Microphone, Gramophone, or Radio inputs.
4. Recording monitor.
5. High Signal to Noise ratio.
6. Pre-set equaliser circuit.
7. Part variable equaliser circuit
8. Sufficient output to modulate all types of tape.

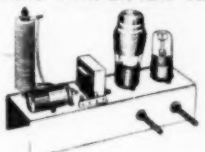
As with all M.O.S. kits, a comprehensive manual gives the fullest details, and the kit itself is complete including pre-drilled chassis right down to nuts, bolts, solder tags, and solder.

Kit COMPLETE with Instruction manual £6.19.6
INSTRUCTION MANUAL ONLY 3/9

HIRE PURCHASE
KIT AS ABOVE ... Deposit £2.0.0
and 12 monthly payments of ... 11/8

COMPLETE "LANE" TAPE TABLE, OSCILLATOR UNIT AND A4 RECORD PLAYBACK AMPLIFIER
Cash £25.19.6
or Deposit £6.19.6 and 12 monthly payments of 35/-

M.O.S AMPLIFIER A2



A complete Amplifier for use on all mains. Tested ready to use **£4.2.6**
Instruction manual 3/-. Or 20/- deposit and 12 monthly payments of 8/6.

Owing to the use of a transformer-less power supply the A2 amplifier is offered at a price which is extremely competitive, and places good equipment in a price range so far unheard of. All the components which form the A2 amplifier are tested and of first grade. Moreover each kit is fully guaranteed.
The circuit is simple and straightforward but by the careful choice of component values the performance is outstanding. Primarily designed for crystal pickups, the amplifier can be used with magnetic pick-up if desired. Output 2.5 to 3 Watts.

Recommended Loudspeaker for A2 Amplifier. 10" *P.M.* **25/-** *extra*

PULLIN MULTI-RANGE TEST SET Series 100

£11.11.0 Deposit £2, and 12 monthly payments of £1.

The universal testing set. SENSITIVITY—10,000 ohms per volt. Strong metal case with carrying handle—complete with leads with detachable bulldog clips and test prods. size 9in. by 5½in. by 4in.

RANGES
AC/DC Volts: 10, 25, 100, 250, 500, 1,000
DC Milliamps: 2.5, 10, 25, 100, 500.
AC/DC Microamps: 100 Microamps 10 Volt range.
Resistance ranges: 0.1 Meg. (13,000 ohms mid-scale).
(10,000 ohms/1V. ohms mid-scale.

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Good TV reception means good sound as well as good picture reception. A TV set should be lovely to hear as well as to look at.

Many TV sets have large cabinets which make excellent baffles and consequently ensure good bass response. But good bass without correspondingly good treble just sounds 'boomy.' In Ultra television receivers we face up to these facts by providing an audio channel of generous output power and bandwidth.

The design of a combined television and radio receiver poses an unusual problem. We think that the radio sound reproduction for such a receiver should be comparable with the high quality reproduction provided by our television sound channel.

But on radio, the bandwidth, and hence the treble response, is restricted usually by selectivity considerations that are not present in television reception. Unless, of course, special precautions are taken, such as an elaborate I.F. amplifier. We at Ultra have solved the problem simply and economically by the use of our neutralized, over-coupled radio I.F. amplifier stage (See Ultra GEN No. 2 — "Wireless World" July, 1951).

By the use of this Ultra development we are able to provide matched audio channels of substantially the same high quality for both radio and television. A unique feature of Ultra combined TV and radio sets.

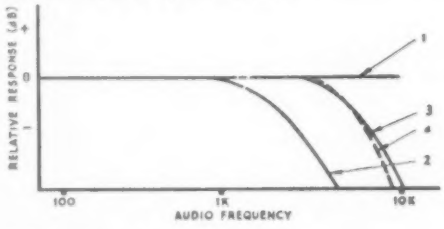
The electrical response curves illustrated show these points:

Curve 1. Response obtainable on TV sound, but only by using an expensive high fidelity reproducer such as a reflex cabinet system.

Curve 2. Radio response showing the attenuation of the "top" that occurs when the radio I.F. amplifier is of the usual type with QK<1. Such a response would sound dull and lifeless compared with that from Curve (1).

Curve 3. Television sound response for good tonal balance with a normal cabinet.

Curve 4. Radio response obtained by using the Ultra neutralized over-coupled I.F. amplifier. Note the close match between this curve and that of the television sound response curve (3).



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Good music deserves FIDELITY in recording and in reproduction

A world-famous Orchestra—playing the loveliest work of a renowned composer—beautifully recorded by the most modern technique—all those amount to very little unless the sound equipment is capable of reproducing the original music with a high standard of fidelity. Specially developed to meet the exacting requirements of music lovers, the GRAMPOLA Model S.50 Amplified Electric Gramophone is an instrument which gives equal satisfaction to the musician and technician alike. Weighing only 21 pounds, it is readily portable, and the two simple controls are fitted on the outside of the case, so that the lid can be closed during playing, eliminating surface noise.

GRAMPOLA Model S.50
Price **£24.12.8** (inc. P.T.)
Amplified Electric Gramophone for A.C. Mains, 50 cycles 200/250 volts.
Weight 21 lb.
Size 14½" × 13½" × 7"

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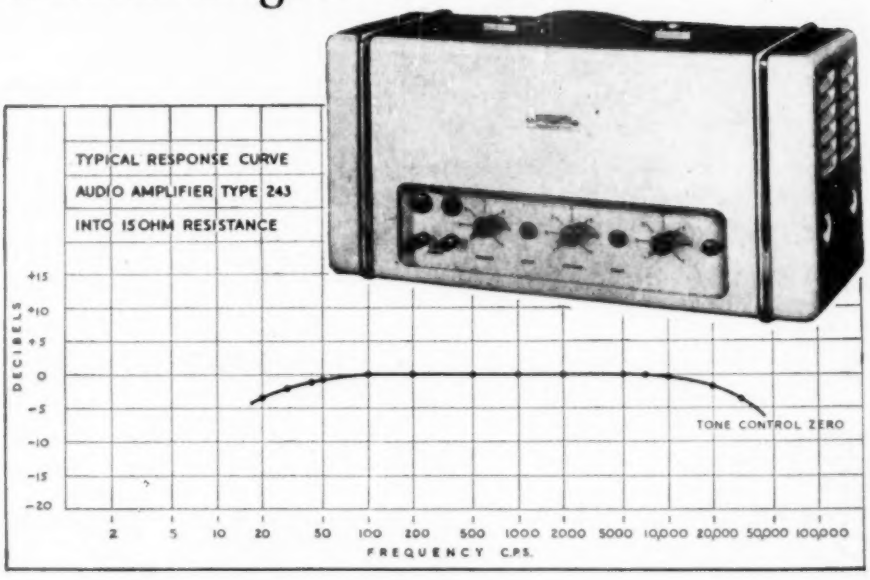

The METROVICK audio amplifier

TYPE 243

The type 243 amplifier is designed for use with high grade public address systems, for the connoisseur of quality and for industrial applications where faithful response over the audio range from 30 to 15,000 cycles is required. This Metrovick instrument is outstanding in its class and provides an output of 20 watts.

SPECIFICATION

Supply: 200/250V 50 c/s single-phase; consumption approximately 170 VA for full output.

Input: Gramophone not exceeding 0.2V for full output. Microphone not exceeding 0.02V for full output. The two circuits can be mixed as required.

Impedance: 7 ohms, 15 ohms and 45 ohms.

Output: 20 watts with negligible distortion.

Tone Control: Continuously variable.

Response: ± 1 db from 30 to 15,000 c/s at zero position of tone control.

Controls: These are recessed to avoid damage and are illuminated when in operation.

Dimensions: 18½"×8½"×10½".

Weight: 60lb. net.

Finish: The instrument is housed in an attractive steel case, stove enamelled in cream or blue as desired. A leather carrying handle is fitted.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, TRAFFORD PARK, MANCHESTER, 17

Member of the A.E.I. group of companies

METROVICK *Applying Electronics to Industry*

RB/101

SPECIAL OFFER

CONTINUITY METER

Dual scale 0-500 ohms and 100,200,000 ohms Moving Coil operated from 4½ volt internal battery. Size 6" x 3" x 4¾". Original price £8 10 0. OUR PRICE BRAND NEW £4 4 0.

RECORD CHANGERS Collaro RC500 with crystal pick-up	£12	3	3
Collaro RC511 with plug-in pick-up either crystal or Hi-Fidelity	£11	16	9
Collaro 3-speed changer	£12	9	9
Plug-in heads for same magnetic	£1	19	6
Plug-in heads for same crystal	£3	2	4
Hi-Fidelity high impedance	£2	6	0
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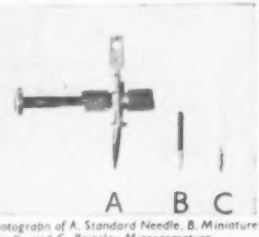

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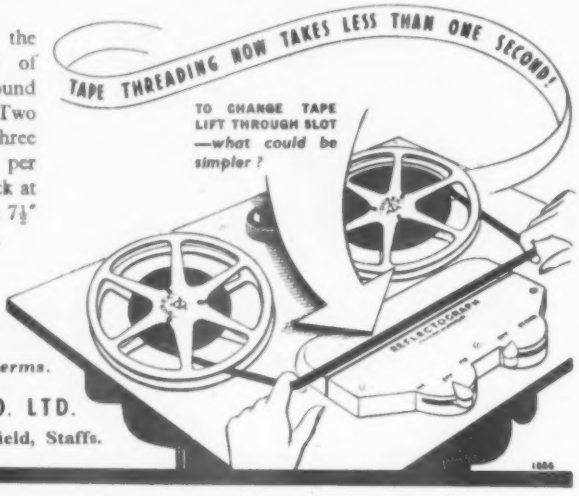

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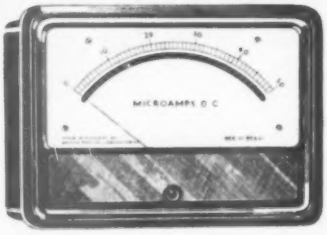

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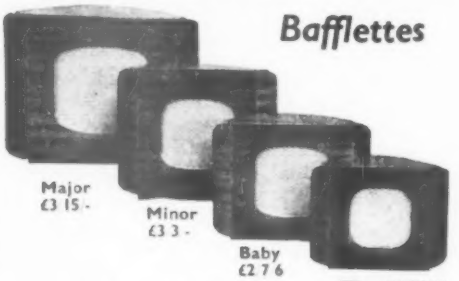

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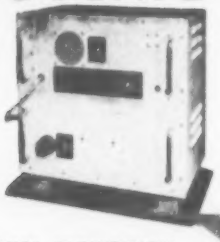

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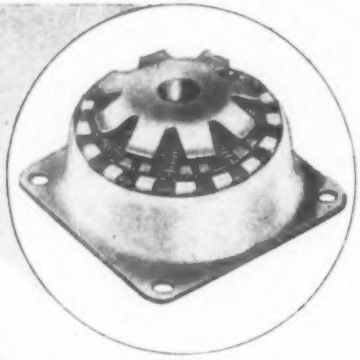

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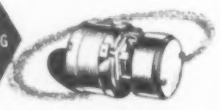

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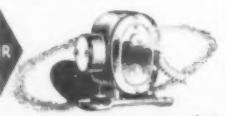

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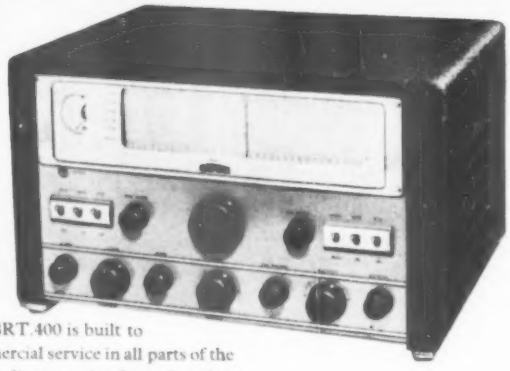

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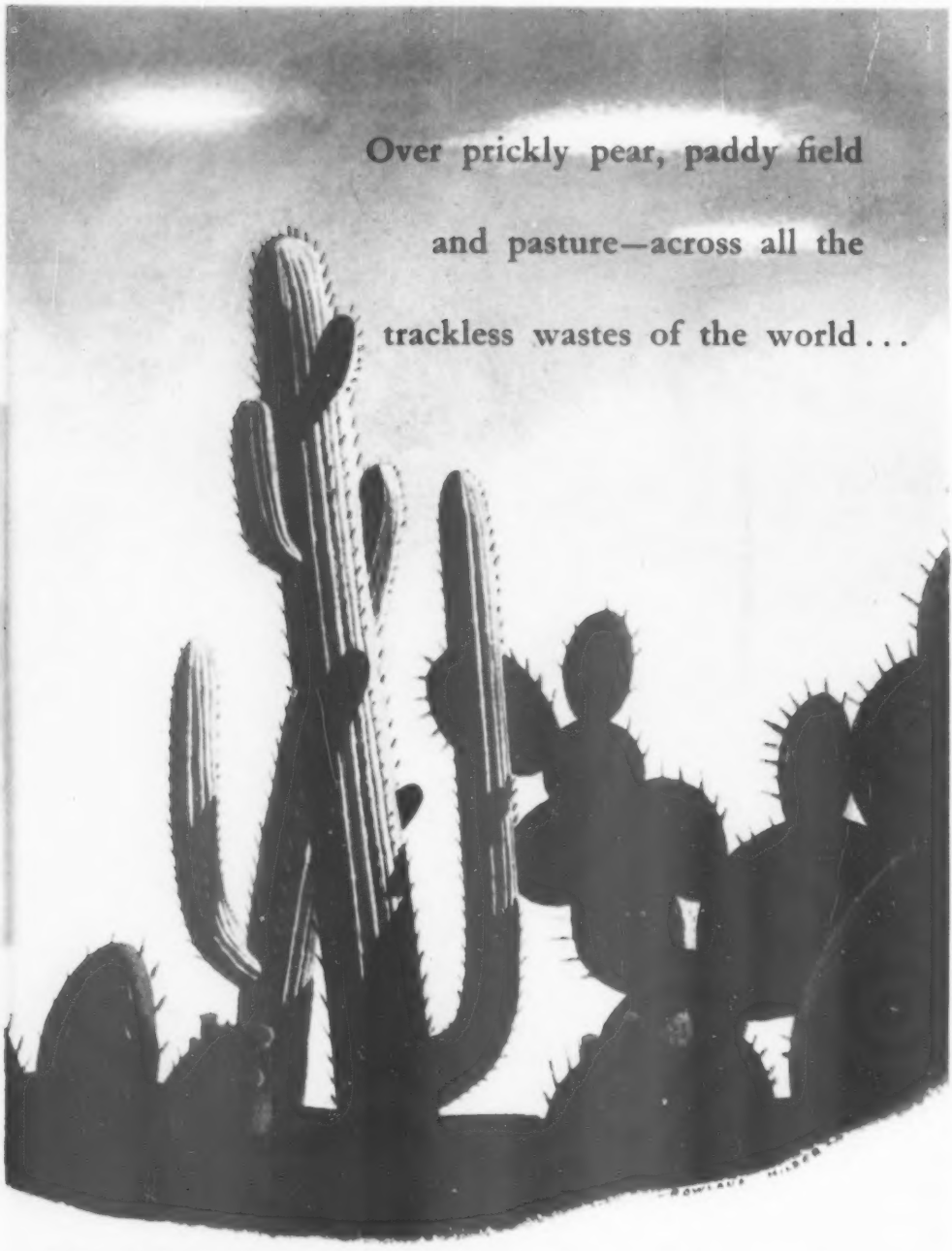

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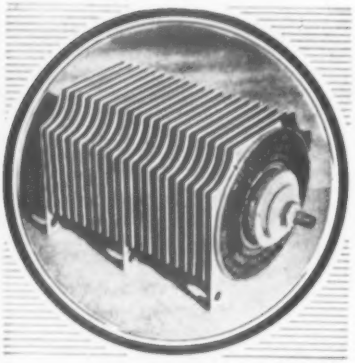

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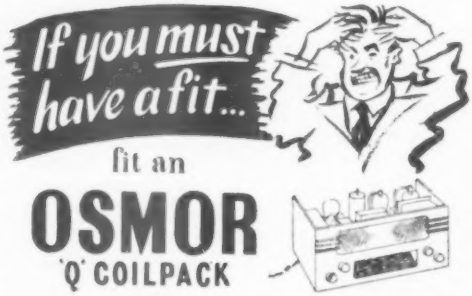

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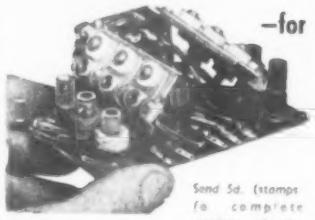

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THE CORNER RIBBON LOUDSPEAKER

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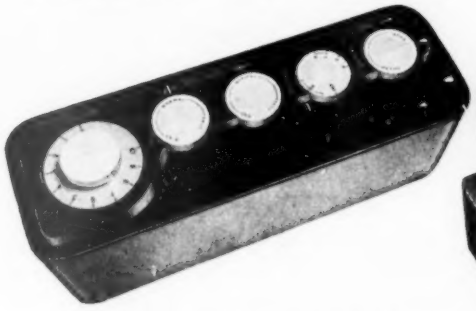

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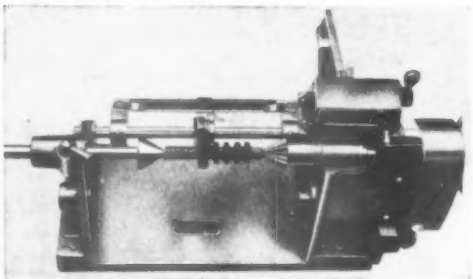

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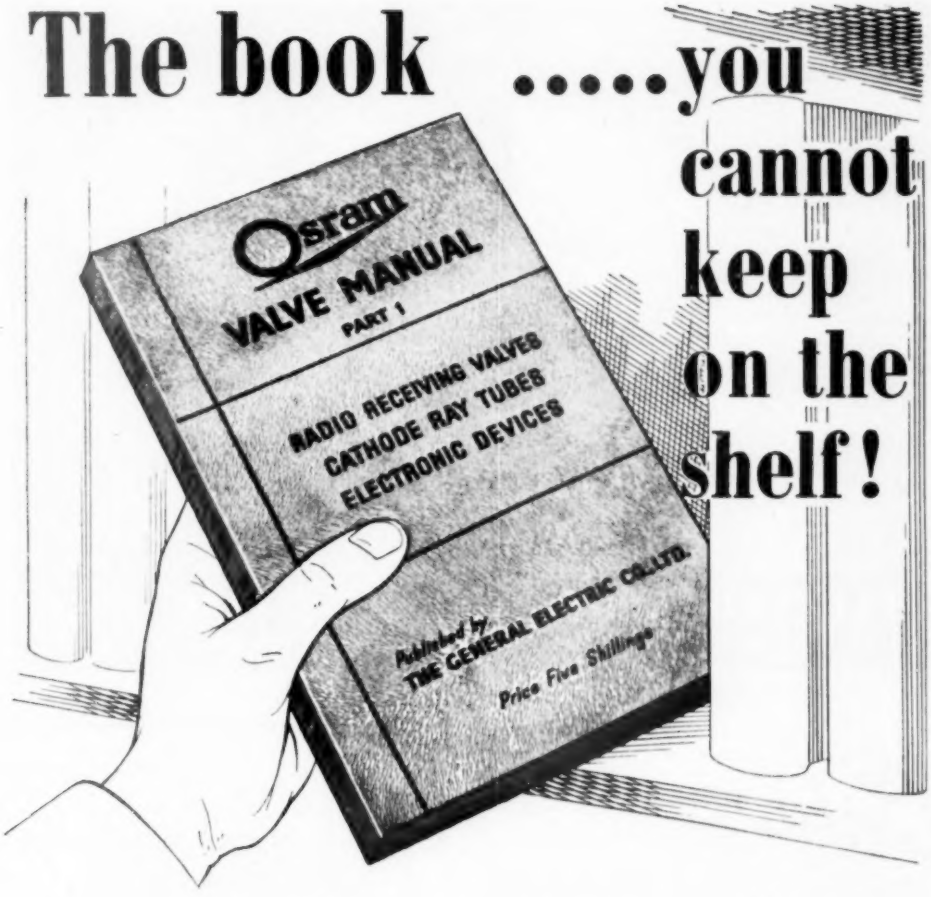

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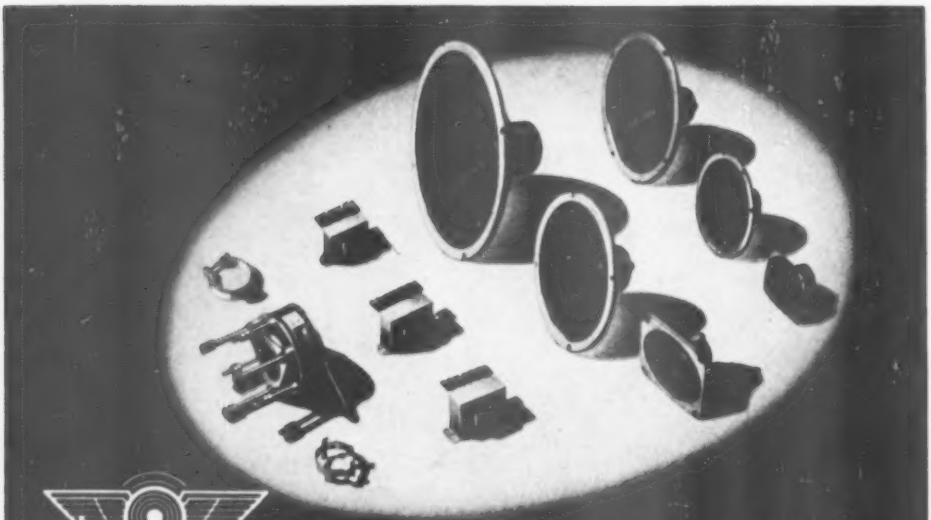

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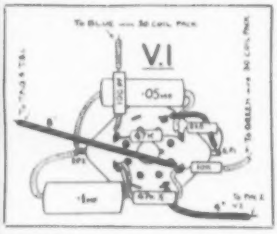

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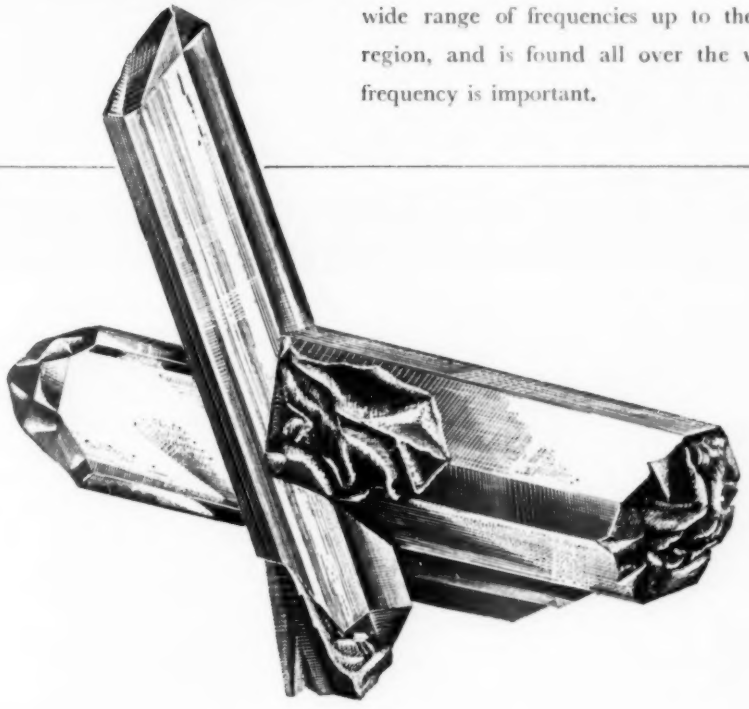

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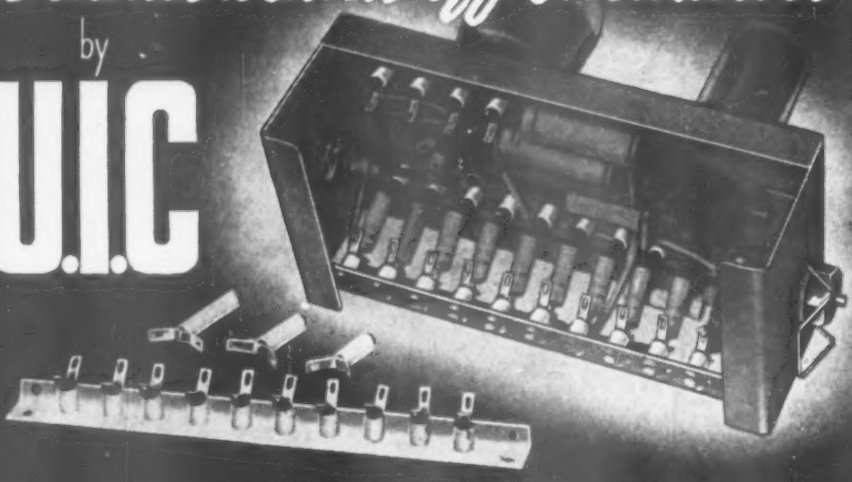

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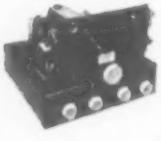
LES. Superhet for areas where reception is more difficult or for greater selectivity than the LEI/2 provides.



DT 4. The most famous tuner of all.

Selectivity Position 1. T.R.F.

Selectivity Position 2. Superhet, wide band.

Selectivity Position 3. Superhet maximum selectivity.

This tuner does not offer a compromise, but fidelity from local stations (1) more general reception (2) and full superheterodyne sensitivity and selectivity (3).

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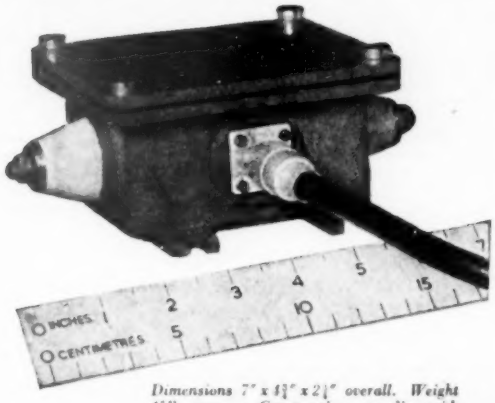
A.T.M.

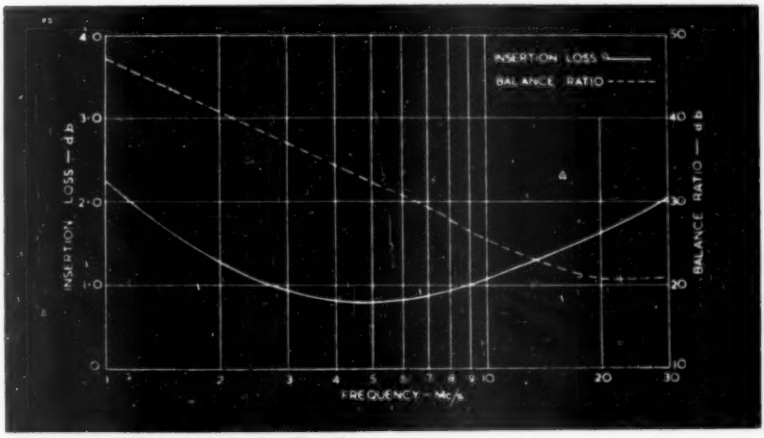
WIDE BAND MATCHING UNIT



Dimensions 7" x 4¾" x 2¼" overall. Weight 4lb. approx. Construction complies with climatic and weather-proof requirements of the relevant Inter-Service specifications.

The "A.T.M." wide band matching unit is designed to meet the need for matching different impedances over an extensive frequency range. The type shown here is for matching a 600-ohm balanced open-wire feeder from a receiving aerial to a 75-ohm unbalanced coaxial cable. Alternative types can be provided for matching other impedance values, either balanced or unbalanced according to individual requirements. The units are compact and light in weight.

Please write for full details.



Characteristics of Wide Band Matching Transformer.
600Ω Balanced: 75Ω Unbalanced. Power rating: 1 watt.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

(RADIO & TRANSMISSION DIVISION)

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Telephone : TEMple Bar 9262 Cablegrams : Strowgerex, London

A.T.M.

A.T.M.63-B.207

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Users include:

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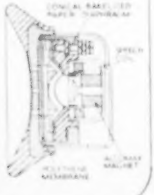

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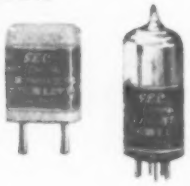

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These items available from stock:

COLLARO 3-RC-511 three-speed AUTO-CHANGERS. 33-45-78 R.P.M. Play 10 7in., 10in. or 12in standard or microgroove records unmixed. Hi-Fi dual purpose head fitted with ACOS cartridge and sapphire. Complete in open type metal case suitable for rack or cabinet installation. Price £19 15 -.

PLESSEY multi-speed AUTO-CHANGERS to play 8-10 records 10in. and 12in. MIXED at 33 or 78 R.P.M. or 8-10 records 7in. only at 33 or 45 R.P.M. ACOS dual sapphire head for standard or microgroove records. Price £23 13 -.

RICHARD ALLAN portable case record player, incorporating Collaro 3-514 3-speed unit for 33, 45 and 78 R.P.M. Dual purpose ACOS pickup head with sapphire. Auto-stop. De Luxe walnut finish cabinet. Price £21 5 4.

CONNOISSEUR de luxe 2-speed motors with heavy lathe-turned 12in. turntable. Speeds 33 and 78 R.P.M., suitable for standard, transcription or microgroove records. Complete on mounting plate, 13½in. x 13½in., ready drilled for the Connoisseur pickup. Price £12 18 8.

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DECCA turnover crystal pickups with twin sapphires, £3 19 4. **MARCONI** 14 lightweight pickup with matching transformer, £2 8 4.

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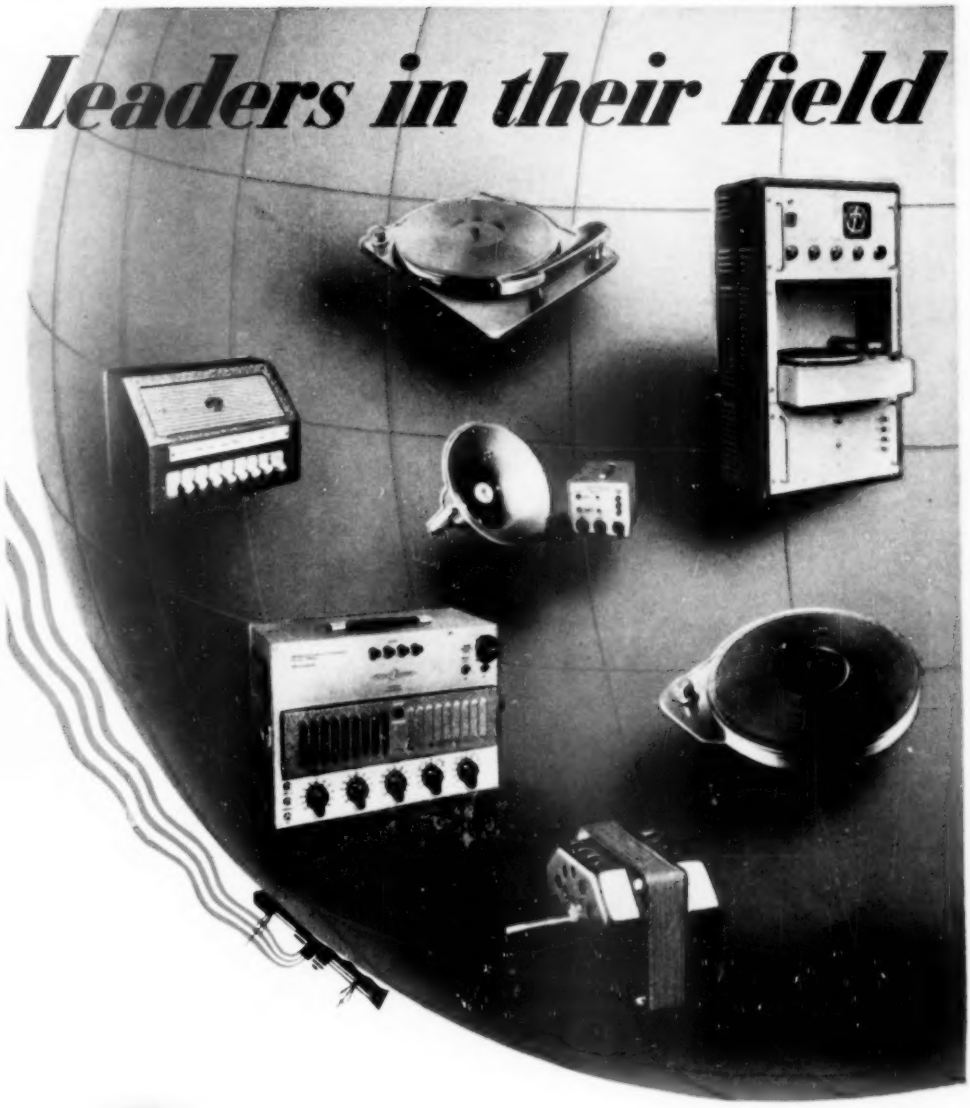

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Leading manufacturers of Sound Reproducing Equipment, Inter-Office-Communicators, Single and Multiple Speed Gramophone Units, Shaded Pole Motors and Beat Frequency Oscillators. Advanced design, a modern well-equipped factory and rigorous stage-by-stage inspection all contribute to the high standards which classify B.S.R. "Leaders In Their Field." You are invited to write for further details.

Birmingham Sound Reproducers Ltd., Old Hill, Staffs. Grams: 'Electronic Old Hill, Cradley Heath.'

And now— the Simphonic TAPE RECORDER Model 1A

TAPE SPEEDS	3¾ and 7½ inches per second
RECORDING TRACKS	Two—side by side
PLAYING TIME	60 minutes per track at 3¾ ins./sec. 30 minutes per track at 7½ ins./sec.
FREQUENCY RESPONSE	50 to 9,000 c/s. at 7½ ins./sec. ±2db
OUTPUT POWER	8 watt
OUTPUT IMPEDANCE	15 ohms. for external speaker
LOUDSPEAKER	6½ inch built-in monitor speaker
INPUT CHANNELS	High impedance for microphone Low or high impedance for radio
POWER SUPPLY	200/250 volts 50 cycles A.C.
POWER CONSUMPTION	100 watts approx.
SIZE AND WEIGHT	18 ins. × 15 ins. × 10 ins.—40 lbs approx.

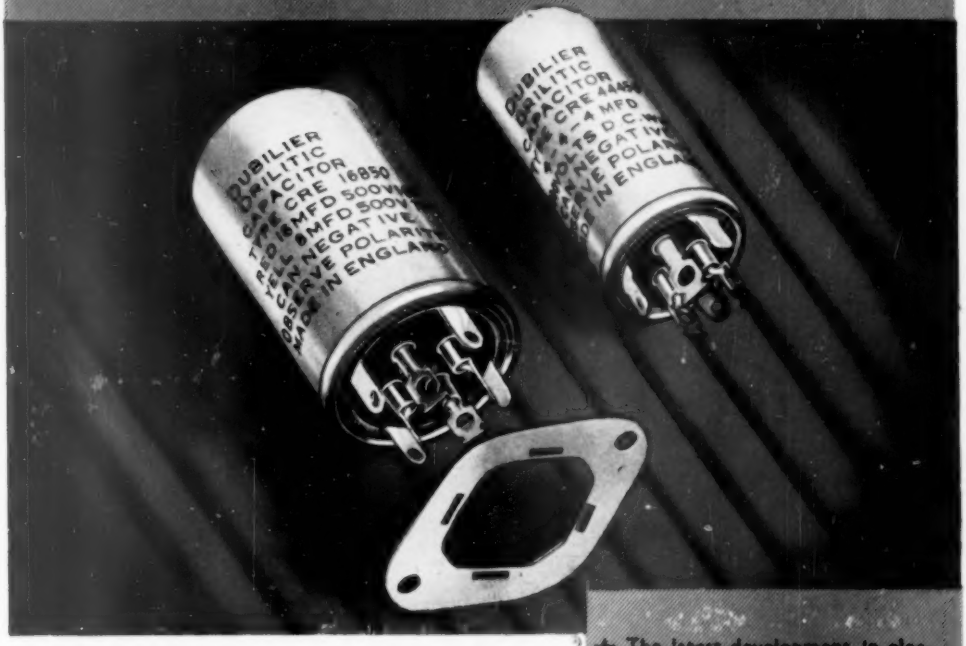
★ The well-known **SIMPHONIC MODEL 2B** is still available for early delivery ★

SIMON SOUND SERVICE

RECORDER HOUSE, 44/50, GEORGE STREET, PORTMAN SQUARE, LONDON, W.1. ENG.

Telephone: Welbeck 2201 (5 lines). Telegrams: Simsonia, Wesdo, London. Cables: Simsonia, London.

MODERN CAPACITOR MOUNTING



EAR MOUNTING DRILITIC CAPACITORS

This modern method of mounting enables the maximum advantage to be secured from the improved electrical characteristics and size reductions of Dubilier Drilitic Capacitors.

No loose parts, clamps, screws or rivets are necessary—a slight twist of the mounting ears and the capacitor is fixed. For chassis-capacitor isolation bakelite mounting plates are supplied; metal plates are available with identical centres for general replacement purposes of the older type capacitors and for interim tooling period.

Ear Mounting Drilitic Capacitors type CTE and CRE have hermetically sealed seamless drawn aluminium containers, have solder tags and are supplied in the usual capacitances and voltages.

Comprehensive catalogues giving detailed information of capacitors and technical service are available upon request.

- ★ The latest development in electrolytic capacitor engineering.
- ★ Minimum chassis space required.
- ★ Easily mounted in a few seconds.
- ★ No loose parts or clamps necessary.
- ★ Perfect chassis-capacitor container contact.
- ★ Speedily converted to older clamp-centres mounting.
- ★ Hermetically sealed seamless drawn aluminium container.
- ★ Improved electrical performance and valuable size reduction. Non-corrosive all aluminium construction.

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DUBILIER CONDENSER CO. (1925) LTD. DUCON WORKS, VICTORIA ROAD, N. ACTON W.3. LONDON, ENGLAND.
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PYE V.H.F. Radio-Telephone

THE "REPORTER" A NEW LOW COST MOBILE RADIO-TELEPHONE

Maximum economy to the user, both in initial outlay and operation, is the outstanding feature of the Pye "Reporter" mobile radio-telephone. Compact, light in weight, and with an extremely low power consumption, the "Reporter" is ideal for all 2-way mobile communication schemes where low capital cost is essential.

SPECIFICATION:

Frequency Range	PTC 116 60-100 mc/s. PTC 117 100-184 mc/s.
The set is intended for simplex working on a "press-to-talk" basis in either double or single frequency schemes.	
Size	9 in. wide x 14 in. deep x 5½ in. high (23 x 33 x 14 cms.) overall.
Weight	17 lb. (7.7 Kg.) including cradle and telephone handset.
Power Supply	6 or 12 V. D.C., positive or negative earth

Power Consumption		
Receiver only	3.0 amps.	At 6 volts these figures are approximately doubled.
Standby	3.5 amps.	
Transmitter	4.0 amps.	
Controls		
On front panel	On/Off switch and A.F. volume control.	
On handset	Receive/transmit pressel switch.	

★ The "Reporter" is suitable for use in tropical climates.

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K.25.B 300-ohms nominal impedance, flat ribbon-type twin; capacitance 4.6 mmf/ft; attenuation at 50 Mc/s, 1.0 db/100ft; power rating at 100 Mc/s 500 watts.

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K.35.B 300-ohm tubular twin feeder with stable characteristics in varying weather conditions. Capacitance 4.0 mmf/ft; attenuation at 50 Mc/s 0.92 db/100ft; power rating at 100 Mc/s, 550 watts.

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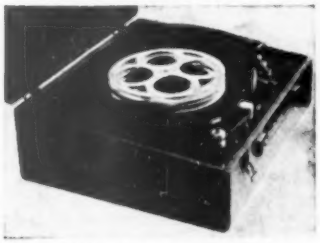
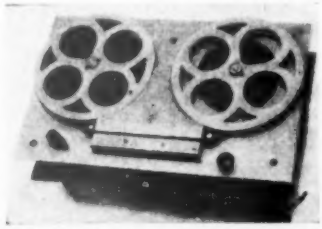
Here is Your Two-Valve Translator



You can magnetically record, using your gramophone motor as a drive and the amplifier within your radio as the tape amplifier. Conversion Kit (readily detachable) containing all necessary parts and instructions. £7, includes postage, etc



★ 1948 We gave you wire recording utilising a gramophone motor
★ 1949 We gave you talking books for the blind
★ 1950 We gave you tape recording utilising a gramophone motor
★ 1952 We give you now for the FIRST TIME in MAGNETIC RECORDING

A Two-Valve Translator

By clever circuitry we have produced for you a 2-valve translator which supersedes costly amplifiers and saves you needless expense. This unique translator will magnetically record from any microphone or pick-up. This unique translator will playback from any make of recorder. It will (without electrical connection to telephones) record 2-way conversations. It will playback into business intercom systems. It will playback into cinema or wireless relay systems.

The translator has both audio and a radio frequency outlet so that any radio receiver tunable to say 900 metres can boost the output to greater volume if desired. This wonderful new TWO-VALVE TRANSLATOR CHASSIS costs only **£12/10/-** ready for use on 230 A.C. Other voltages to order.

The Diamond Tape Recorder. Two speeds (Diction 2 hours, Music 1 hour). Twin tracks. Fast forward wind and fast rewind. Strongly built for hard work. Can be used with any conventional amplifier or the translator **£25**, including choice of tape, Diamond, Scotch Boy, E.M.I. G.E.C.

Recording playback and erase heads for home assembly.
Bandeau Type 7.6 pair. Record/playback and erase. Kit contains all parts and instructions.
Cassette Type 30/-. Contains both record/playback and erase heads in one housing. The heads can be changed about according to tape direction (erase should precede record head). Gaps are adjustable. Cores are stacked mumetal half width for 2-way tracking. Bobbins ready wound Hi or Lo impedance to choice.

Oscillator coils **6/6.** For generating 45Kc supersonic bias currens and erase current. Primary and secondary windings for Hi or Lo impedance heads.

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Mullard GENERAL PURPOSE OSCILLOGRAPH TYPE E805

This Cathode Ray Oscillograph is for general purposes. But it incorporates many features not normally found in such instruments. It covers a very wide range of frequency, including the whole frequency spectrum used in television. And it's equally well suited for research work, production testing or transmission monitoring. Many of Industry's high frequency problems can be solved with this oscillograph's aid — particularly those problems of motor-car ignition, flash-over on insulators, discharge at high voltages, etc.

- 3½" cathode ray tube with 1,250 volt final anode potential.
- Beam modulation. External blanking of beam for timing purposes and eliminating retrace.
- Beam suppression prevents "fogging" of film when camera shutter is open.
- Single stroke operation for non-recurrent phenomena or photographic recording.
- Calibrated step-type input attenuator with coarse and fine adjustment.

The Mullard Cathode Ray Oscillograph, type E.805. Dimensions: Height 14" ; Width 9" ; Length 15½". Please write for detailed information.

SPECIFICATION

Amplifier. Gain 1,400 or fmV rms/cm. Frequency range 2 c/s-2 mc/s. 3 dB loss.

Attenuator. Stepped 5-10-20-35 mV cm. Multiplier x 1, x 10, x 100 x 1000. Maximum input 250 V. rms.

Time Base. 5 c/s-150 Kc/s in 10 steps with continuous variation between steps.

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MIDLAND AGENT: *Hadley Sound Equipments, Ltd., 72, Cape Hill, Smethwick. Tel.: Smethwick 0977*

SCOTTISH AGENT: *Land, Speight & Co., Ltd., 73, Robertson Street, Glasgow, C.2*

Mullard Ltd., Equipment Division, Century House, Shaftesbury Avenue, London, W.C.2. Telephone: Gerrard 7777

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Mk. I £58 5 6
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"Magnetic Recording" by S. J. Begun. Post free £1 6 0

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33⅓ and 78 spds. £3 14 4
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AVO

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Uniminor	£10 10 0
Univ. Bridge	£26 0 0
Wide Band Signal Generator	£30 0 0
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Electronic Testmeter	£40 0 0

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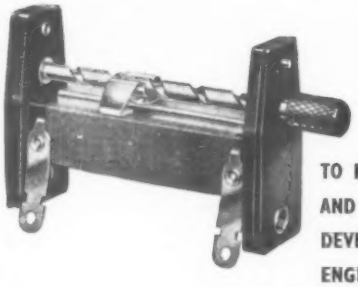
ALL THE NEW TAYLOR TEST-GEAR IN STOCK AND AVAILABLE ON H.P. TERMS. Send S.A.E. for catalogue and terms.



TO RADIO AND T/V DEVELOPMENT ENGINEERS

This midget pre-set variable resistor with new double-slider gives greater stability and makes accurate adjustment easier. Designed for panel or chassis mounting: available in any value from 10 to 25,000 ohms.

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ACE Radio Chassis

This range of High Quality Radio Chassis designed and built to exacting specification by skilled engineers is

now available from

MAJOR DISTRIBUTORS LTD.

Model 600

9 valve, 9 waveband bandspread receiver covering the following ranges: 11, 13, 16, 19, 25, 31, 41 and 49 metre bands on 7 bandspread ranges. Also either medium wave 180–550 metres and long wave 800–2,000 metres, or medium wave and trawler band (60–150 metres). 10 watts push-pull output feeding twin 10in. speakers. Magic eye tuning indicator, employs Octal range of valves, RF stage on all bands. A.C. mains only 200/250. **£36.2.4**

Model T875

8 valve, 7 waveband bandspread receiver covering 11, 13, 16, 19, 25, 31, 41 and 49 metre bands on 5 bandspread ranges and medium and trawler bands in 2 ranges from 130–570 metres, no long wave. This receiver, by utilising the ingenious Ace selector system of splitting the medium band, gives a much better medium wave performance than that of competitive receivers covering 180–550 on the one band. Magic eye tuning indicator, push-pull output, 10 watts feeding twin 8in. speakers, employs the latest type miniature valves. A.C. mains only 110/250. **£28.17.8**

Model T845

8 valve, 4 waveband receiver covering 1,000–2,000 metres, 270–570 metres, 130–275 metres and 16–33 metres. Medium wave performance is similar to Model T875. 10 watts push-pull output feeding twin 8in. speakers. Magic eye tuning indicator, and employs the latest type miniature valves. A.C. mains only 110/250. **£23.10.2**

Model T675

6 valve, 7 waveband receiver, waveband coverage and specifications exactly as T875 except that push-pull output is not used and one 8in. speaker is employed. 3.5 watts output, A.C. mains only 110/250 v. **£23.10.2**

Model U675

Specification as Model T675 but for AC/DC mains operation, 200/250 volt. **£23.10.2**

Model T645

6 valve, 4 waveband receiver, waveband coverage and specifications exactly as Model T845 except that push-pull output is not used and one 8in. speaker is employed. 3.5 watts output. **£18.1.0**

Model U645

Specification as Model T645 but for AC/DC mains operation 200/250 volt. **£18.1.0**

We can give immediate delivery on all of the above models.

All prices nett ex works, packing and transport extra

MAJOR DISTRIBUTORS LTD.

TOWER WORKS, POUND LANE, LONDON, N.W.10
Telephone: WILlesden 6713.

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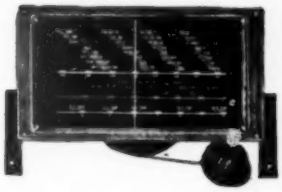

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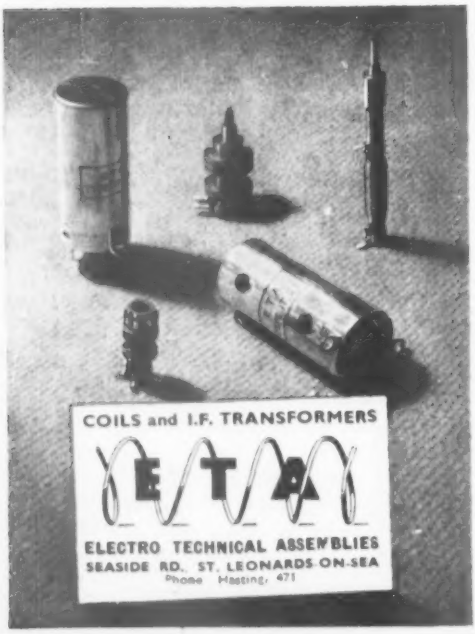

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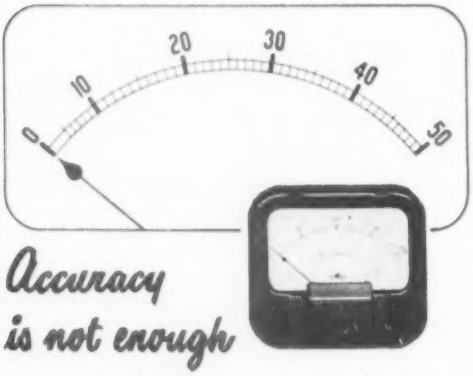

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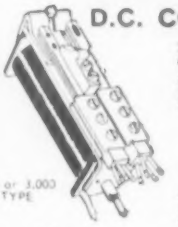

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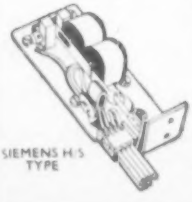

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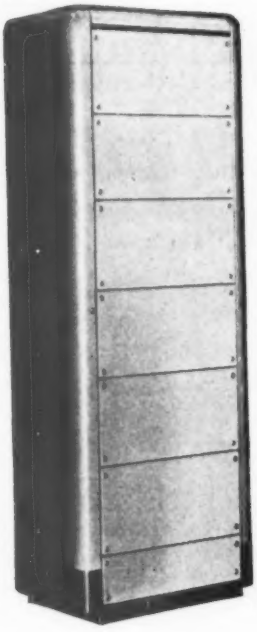

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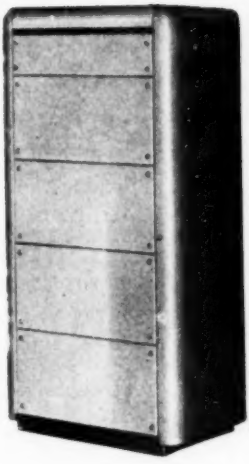

Quick delivery, no tooling charges, competitive prices due to quantity production and no design worries are some of the advantages offered by Imhof's Standard Enclosed Racks, advantages also to be had in the semi-standard sizes. Illustrated are the standard 6ft. and 4ft. racks, 19in. in depth and taking a 19in. G.P.O. type panel. Racks can be bolted together to form multi-units. Semi-standard racks have a depth of 24in. and take a 22½in. panel and can be fitted with an inner mounting panel and front door. There is a wide range of standard extras including chassis, handles, telescopic runners, mobile bases, gram and desk units, etc. Generous air passage provides adequate ventilation. Quotations can be given for non-standard modifications.

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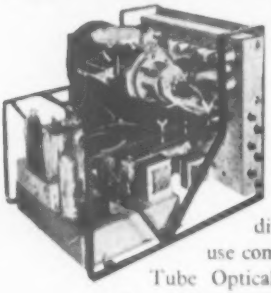

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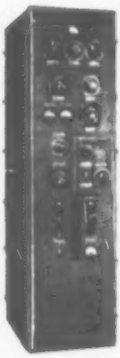

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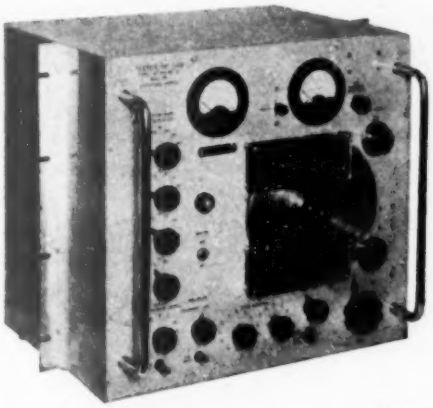

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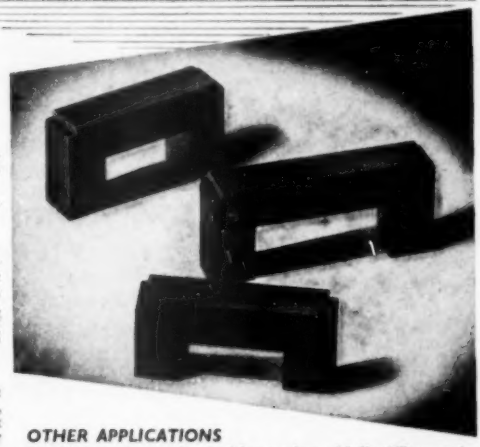

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In addition to its uses in television receivers, Mullard Ferroxcube is also being widely employed in line communications, radar, and other specialised electronic equipments. The purposes for which it is already being most successfully applied in such equipments include filter networks, wide band transformers, magnetic amplifiers, and pulse transformers.

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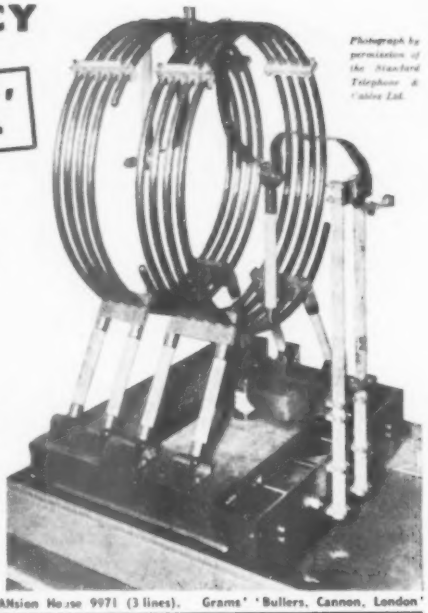

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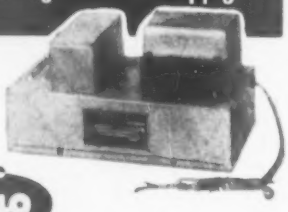

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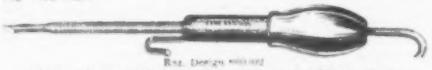

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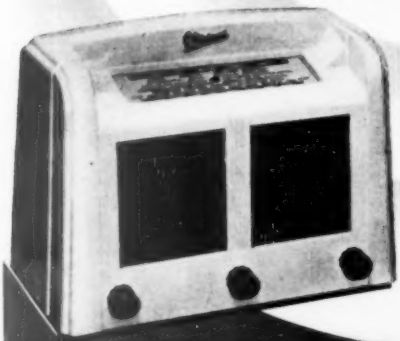

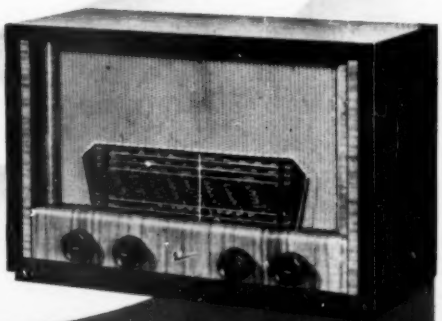

5 Valve AC/DC Superhet Table Receiver. Weighing 17 lb. (8.1 kg.) the T28BDC is a superhet with address valve for extra sensitivity and stability. Inbuilt aerial for normal medium wave reception. For longer ranges and the two short wavebands, an aerial should be connected to the socket provided. Finished in cream plastic with polished carrying handle.

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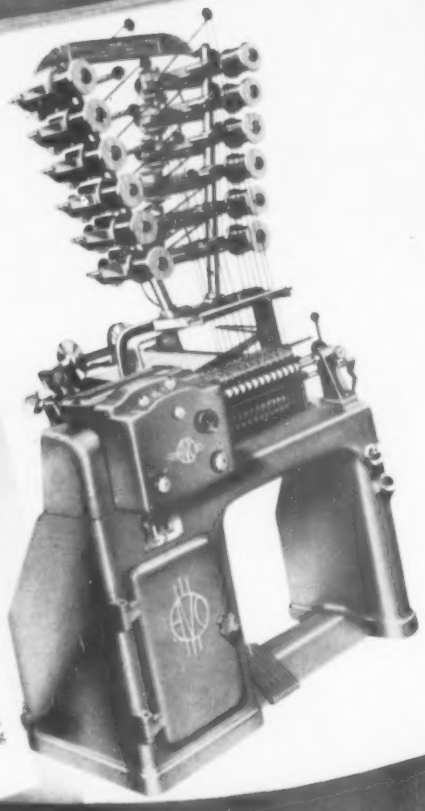

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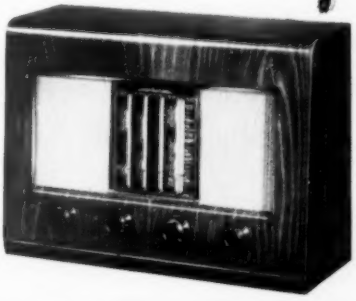

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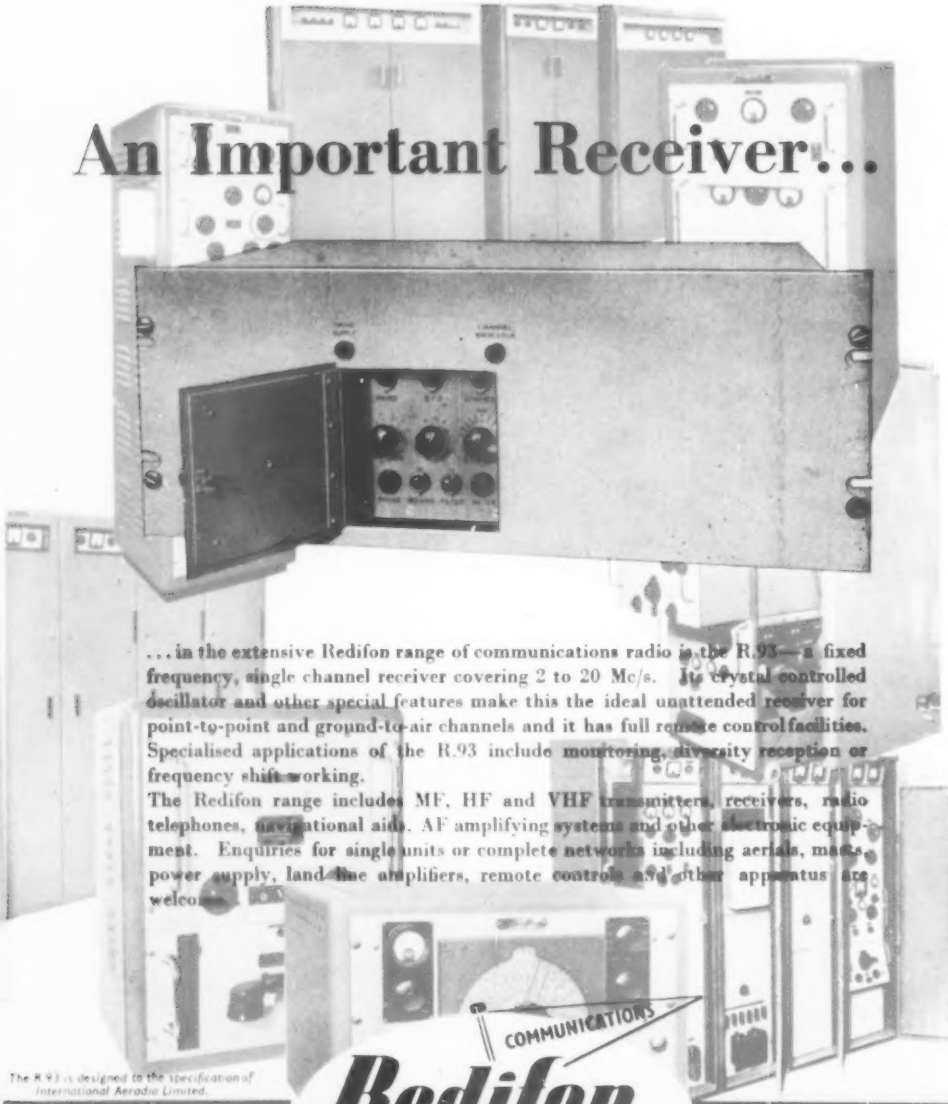

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Wireless World

RADIO, TELEVISION AND ELECTRONICS

41st YEAR OF PUBLICATION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: H. F. SMITH

JANUARY 1952

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PUBLISHED MONTHLY: Price 2/- (last Tuesday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Ethaworld, Sedist, London." *Annual Subscription:* Home and Overseas, £1 7s. 0d. U.S.A. $4.50, Canada $4.00. BRANCH OFFICES: *Birmingham:* King Edward House, New Street, 2. *Coventry:* 8-10, Corporation Street. *Glasgow:* 26B, Renfield Street, C.2. *Manchester:* 260, Deansgate, 3.

VALVES...and their Applications

INDIRECTLY-HEATED VALVES FOR BROADCAST RECEIVERS

The Output Stage

The three Mullard output pentodes in the B8A range are types EL41, EL42 and UL41, which have been developed to meet all the requirements for normal receivers. Types EL41 and UL41 are rated for 9W maximum anode dissipation and give 4.2W output at 10% total distortion. They are the valves normally used in A.C. and D.C./A.C. mains sets respectively.

Type EL42 is rated for 6W maximum anode dissipation and will give 2.5W output at 10% total distortion. It is particularly suitable for use in car radio sets, by reason of its economy in both H.T. and L.T. consumption and its compact dimensions. Two of these valves can also be used in push-pull in A.C. mains sets, to give an output greater than that of a single EL41, and with much lower distortion. Push-pull outputs up to 7W may be obtained.

Due to losses in the output transformer, the effective output of a receiver or amplifier is usually at least 15% less than that obtained from the power output stage. Values of power output given in the published data correspond to conditions in which the load impedance is purely resistive. In practical cases account must be taken of the fact that the impedance of a loudspeaker load varies with the frequency, and for matching purposes the average impedance at frequencies between 800 and 1,000 c/s should be taken.

In a five-valve mains superhet (including rectifier), where a triode A.F. amplifier usually precedes the output valve, the voltage gain is sufficient to permit the application of negative feedback over the two stages, preferably including the output transformer, thus facilitating adjustment of the frequency response and reducing distortion. The maximum benefit of negative feedback is obtained by using an output valve of high power sensitivity. With the EL41, for example, the drive voltage for an output of 4.2W is only 3.7 Vr.m.s.

The power sensitivity of the UL41 is, however, considerably less, the drive voltage for 4.2W output being 6.0 Vr.m.s. This is because in D.C./A.C. mains receivers the output valve must be capable of giving the required output when operated at anode and screen voltages not greater than 200V. This requirement necessitates a valve with a greater anode current for the same dissipation, which means, in effect, a lower impedance and amplification factor, and hence reduced power sensitivity.

OUTPUT PENTODES

Type EL41 for A.C. Mains Radio Sets.
Type EL42 for Car Radio Sets.
Type UL41 for D.C./A.C. Mains Radio Sets.

	EL41	EL42	UL41
Heater			
V_h	6.3	6.3	45 V
I_h	0.7	0.2	0.1 A
Characteristics			
V_a	250	225	170 V
V_{g2}	250	225	170 V
V_{g1}	−7	−11	−10.4 V
R_k	170	360	170 Ω
I_a	36	26	53 mA
I_{g2}	5.2	4.1	10 mA
g_m	10	3.2	9.5 mA/V
r_a	40	90	20 KΩ
R_a	7	9	3 KΩ
$V_{in\ (r.m.s)}$	3.7	7.2	6.0 V
P_{out}	4.2	2.5	4.2 W
D_{tot}	10	10	10 %
Limiting Values			
$V_{a(b)}$	max. 550	550	550 V
V_a	max. 300	300	250 V
p_a	max. 9	6	9 W
$V_{g2(b)}$	max. 550	550	550 V
V_{g2}	max. 300	300	250 V
$p_{g2(o)}$	max. 1.4	1	1.75 W
I_k	max. 55	35	75 mA
V_{h-k}	max. 50	50	150 V

THE COMPLETE SERIES

	FREQUENCY CHANGER	R.F. OR I.F. AMPLIFIER	DET., A.F. AMPL. FR. & A.V.C. DIODE	OUTPUT PENTODES	RECTIFIERS
6.3 V Heater	ECH42	EF41	EBC41	EL41; EL42	EZ40; EZ41
0.1 A Heater	UCH42	UF41	UEC41	UL41	UY41

Reprints of this article together with additional data may be obtained free of charge from the address below.

Mullard

MULLARD LTD., Technical Publications Department, Century House, Shaftesbury Avenue, W.C.2.

MVM182

Wireless World

JANUARY 1952 VOL. LVIII. No. 1.

Radio Politics

WE may all be thankful that the important part played by radio in our national life is universally recognized. There are fewer grounds for self-congratulation, however, in the undoubted fact that radio in general, and in particular the control of broadcasting, is becoming increasingly a matter for political controversy.

Of course, no reasonable person would deny that the future of broadcasting in this country should be debated in Parliament before the B.B.C. charter and licence are renewed. Equally, the wisdom of extending the charter for six months to allow of mature consideration and preliminary discussion will be conceded. But there seems to be a danger that the issue may be clouded by party-political acerbity and doctrinaire ideology.

When the Beveridge Report was issued about a year ago, nearly everybody believed it would form at least the basis for the new charter; in other words, that there would be no drastic changes. Even now, such an exhaustive report, prepared under the leadership of such a distinguished chairman, can hardly be ignored, but there is a probability that certain matters of principle may come under attack.

Can a good case be made out by those concerned in the future of radio generally for violent and disruptive changes? On the face of it, the best argument to the contrary is that the broadcast licence figures show something very closely approaching saturation. Hazarding a guess as to the number of those unlicensed "pirates" who have lately been giving the Postmaster General some concern, we may say that 95 per cent of homes are already radio-equipped. We hope we are not unduly over-cautious or conservative in wondering whether it is worth taking the risk of introducing some drastic change (that may antagonize many existing listeners) on the off-chance of drawing the remaining 5 per cent into the fold.

So far as the main sound service of the B.B.C. is concerned, it may safely be assumed that the retention of the monopoly will not be strongly questioned, though the question of advertising or sponsored programmes will be hotly debated. This battle, however, promises to be most violent in regard to television, where the high cost of programme material provides an argument in favour of it.

It seems to us that the advocates of advertising programmes would do well, as a start, to press for experimental use of metre-wave broadcasting for this purpose. The Beveridge Report has already paved the way for independent operation of stations in this band, but, as we tried to show in our November issue, it is extremely doubtful if such stations could be successfully operated without advertising revenue. This is an experiment that might well be tried, and we do not imagine that the idea would meet with the widespread opposition that would certainly be forthcoming to any suggestion for interfering with existing services.

The question of television in the cinemas seems also likely to become an issue in which political intervention is particularly undesirable. The Post Office, by saying in evidence to the Beveridge Committee that cinema television "amounted to something very like broadcasting," was originally responsible for throwing this particular victim into the political arena. We are sorry to see that the present Postmaster General has apparently adopted very much the same attitude as that of his predecessor in office by refusing to grant licences until the matter is put before Parliament. Surely it is within his present rights to grant the necessary licences; no new principle is involved. Under the Telegraph and Wireless Telegraphy Acts, it seems reasonable to us to say, in the legal sense, that television in the cinema amounts to nothing more than moving pictures sent by line or radio telegraph. *Wireless World* does not remember that the Post Office sought Parliamentary sanction when it first allowed its licencees to transmit still pictures by radio. Unfortunately, this matter of cinema television has become thoroughly confused and nothing seems to have been done to clarify it since we first drew attention to the muddle in March, 1951. Here is a case where a particularly promising development in which Britain has played a leading part is being held up quite unnecessarily.

LOUDSPEAKER WITHOUT DIAPHRAGM

Direct Modulation of Ionized Air

THE loudspeaker, as we know it today, is admittedly the weakest link in the chain of elements required for faithful sound reproduction. Attempts to improve the moving-coil-driven diaphragm unit are inevitably balked by the limitations imposed by its mass and the difficulty of controlling flexure of the diaphragm. Then why not scrap the principle and try something fresh? Ionize the air particles and move them directly under the influence of an electric field, for instance.

The idea is not new. It was used by Duddell in 1900 in his singing arc, and has been tried with electrodes introduced into the highly-ionized regions of gas flames. Neither method is particularly efficient or convenient for general use, and the idea has lain dormant for many years, awaiting the development of a more efficient source of ionization.

In 1946, S. Klein described[1, 2] a prolific source of positive ions consisting of a mixture of 50 per cent precipitated platinum, 40 per cent aluminium phosphate, 5 per cent precipitated iridium and 5 per cent graphite, and showed that it could be used as an active anode to produce powerful ionization of air at normal atmospheric pressure under the action of an electric field. He suggested that an ionization cell of this nature could be used for the generation of infra- and super-sonic waves in air, and as a microphone or loudspeaker.

In the original design the anode was heated by a separate filament, and modulation was superimposed on a steady potential of about 700V between the emissive anode and a cylindrical cathode. An alternative arrangement showed the introduction of a control grid, which gave an arrangement rather like a polarity-inverted triode. Curves of current against applied voltage showed the relationship to be non-linear, but the author stated that oscillograph examination of the current had shown a sensibly linear relationship over the range of pressures used when the cell was tested as a microphone down to frequencies of a few cycles per second.

Further work on the device as a loudspeaker has caused Klein to revise his original circuit and he now uses a high-frequency field (400 kc/s) of about 10 kV between anode and cathode. The active material is no longer separately heated by a filament but is maintained at a temperature of the order of 1,000°C by electron and ion bombardment.

Fig. 1 shows one form of cell which we have recently had the opportunity of seeing and hearing. The active anode coating is at the tip of a quartz tube through which a single connecting wire passes. The electrode slips inside another quartz tube with a locating constriction and this tube is contained in a fused quartz envelope, the intervening space being evacuated to provide, according to the designer, thermal insulation and additional dielectric strength. The cathode is an aluminium cylinder of about 3in diameter and 4in long and is provided with a screw joint for connection to an exponential horn. The inside diameter of the quartz cell is about ¼in and is of parallel bore in the specimen illustrated, but there is no reason why it should not be given an exponential taper to match the horn. The space between the quartz cell and the cathode is filled with glass wool.

Two pentodes in parallel (each of the order of 20 watts anode dissipation) are used to generate the r.f. excitation. The basic circuit is shown in Fig. 2 from which it will be seen that modulation of both anode and screen voltage is employed. The modulated r.f. output voltage is high and is capable of sustaining a spark of ½in or so in air between ordinary electrodes.

According to the original descriptions, the cell requires a warming-up period of anything from several seconds to a minute, though in the demonstrations we saw, the discharge seemed to strike as soon as the r.f. is applied, and re-establish itself instantly after being allowed experimentally to cool down. The discharge between the active deposit and the aperture in the tube is orange in colour and violet for the half-inch or so to which it extends on the other side of the constriction. It appears to be quite stable in shape and fans out along the equipotential lines towards the cathode until it impinges on the walls of the tube. Occasional bright points may be seen travelling through the discharge, always in a direction from anode to cathode, from which it may be concluded that the average drift of some of the heavier positive ions is relatively slow and also that some rectification of the r.f. current is taking place.

The unmodulated discharge generates a characteristic random background hiss which is at a slightly higher level than that of the surface noise on the average shellac gramophone disc. A test demonstration with recordings of the singing and speaking voice, played through a pickup and a 10-watt a.f. amplifier and applied to the modulating winding of the r.f.

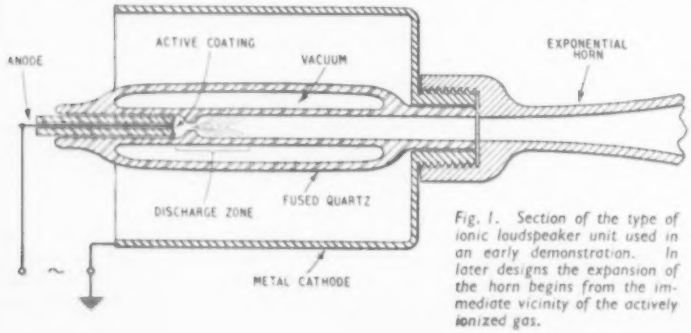

Fig. 1. Section of the type of ionic loudspeaker unit used in an early demonstration. In later designs the expansion of the horn begins from the immediate vicinity of the actively ionized gas.

generator, gave surprisingly good quality at a level approximating to that at which the average table model radio set is used. Above this level some distortion was obvious, and the discharge in the cell was visibly interrupted on peaks. It is only fair to add that some trouble had been experienced with the generator just prior to the demonstration and that near equivalents to the designer's original valves had to be substituted at the last minute. This probably restricted the power handling capacity of the generator.

Frequency response curves for constant voltage input have been published[3, 4, 6] and are remarkably uniform, showing deviations of ± 5db or less over the range from 25 c/s to 10 kc/s. The curves show no signs of falling off as the latter frequency is approached. It is virtually certain that "hangover" transients will be completely absent, since the inertia of the active gas molecules is negligible compared with that of the lightest conventional diaphragms.

What is not so certain is that the amplitude characteristic is linear over the dynamic range required for the reproduction of orchestral music. As far as we know, nothing has yet been disclosed on this score and it may turn out that non-linearity, with consequent intermodulation, is the Achilles heel of what otherwise appears to be a very promising principle. The ionization process in a gas is very complex and the relationship between current and the applied voltage is not linear, even under conditions of constant pressure. The relationships between gas pressure and temperature, and the kinetic energy imparted to ions under the influence of the electric field have been explored by Klein[5], with special reference to the action of the cell as a microphone; but the results are only tentative and do not necessarily apply to the case of the loudspeaker, where the instantaneous temperature, pressure and volume are varying over a much wider range.

Final judgment may reasonably be deferred until measurements of the electro-acoustic amplitude transfer characteristic have been published. If first results are unfavourable there is still the possibility of applying feedback to straighten things out, though whether this is feasible without a monitoring microphone and its attendant complications remains to be seen. A pair of auxiliary probe electrodes in the high-pressure region of the horn throat might afford a solution.

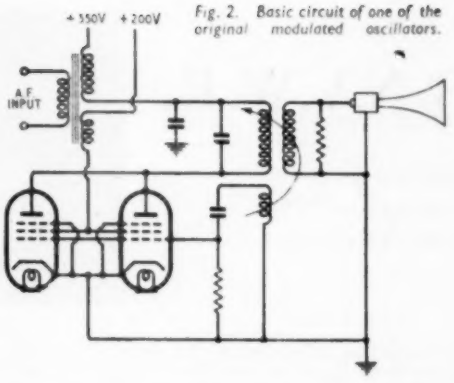

Fig. 2. Basic circuit of one of the original modulated oscillators.

If a satisfactory answer to these questions is forthcoming, the "Ionophone" loudspeaker, as it has been named in France, may herald a drastic revolution in receiver design. It has been suggested[7] that since the input to the loudspeaker is modulated i.f., all one needs is a power i.f. amplifier between the frequency changer and the loudspeaker terminals, with a separate synchronized r.f. source which may be added to the input carrier to vary the effective depth of modulation and thus to provide a means of volume control. In this way the second detector and a.f. stages and their possible distortions would be eliminated. F. L. D.

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2. *L'Onde Electrique* No. 235, Oct., 1946, p. 367.
3. *Comptes Rendus*, Vol. 233, No. 2, p. 143 (July, 1951).
4. *TSF Pour Tous* No. 275, Sept., 1951, p. 278.
5. *TSF Pour Tous* No. 276, Oct., 1951, p. 340.
6. *Toute la Radio* No. 159, Oct., 1951, p. 251.
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TECHNICAL WRITERS' PREMIUMS

IN last month's issue we gave some particulars of the Radio Industry Council's scheme for encouraging technical writing. Full details have now been announced.

From 1st January, 1952, the R.I.C. will award premiums of 25 guineas each, up to an average of six a year, to the writers of published articles which, in the opinion of a panel of judges, deserve to be commended by the industry.

Any non-professional writer is eligible—and by this is meant anyone not paid a salary mainly or wholly for writing and not earning 25 per cent or more of his income from fees for articles or from book royalties.

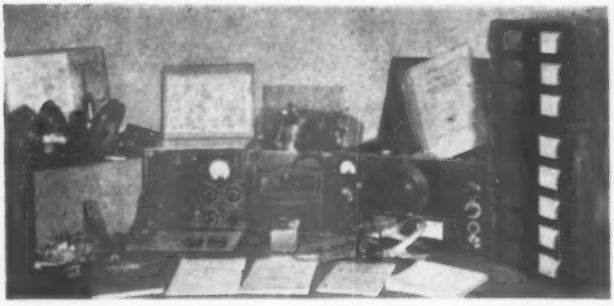
The awards will be made for articles published at home or abroad in papers or periodicals which can be bought by the public on the bookstalls or by subscription. Articles in the following classes of journals will not be eligible: journals circulating exclusively to members of a trade or manufacturers' journals; the privately published journals of professional institutions or learned societies. Writers and editors will be invited to submit published articles for consideration to the Secretary, R.I.C., 59, Russell Square, London, W.C.1 (with, if possible, five copies of the journal, proofs or reprints). The judges will consider also unsubmitted published articles.

The judges are given the greatest possible freedom in choosing articles for awards, but they are asked broadly to take into consideration: value of the article in making known British achievement in radio and electronics; originality of subject; technical interest; presentation and clarity.

The judges are: E. M. Lee and T. E. Goldup, Technical Directive Board, R.I.C.; W. M. York, Chairman, Public Relations Committee, R.I.C.; Vice-Admiral J. W. S. Dorling, Director, R.I.C.; Professor Willis Jackson, Professor of Electrical Engineering, Imperial College of Science and Technology, University of London. The panel will have power to co-opt specialists.

R.N.V.W.R.

Reserve of Naval Telegraphists and Radio Electricians



Equipment issued to Reservists for use at home includes a 30-watt portable h.f. transmitter (Type 5G) and a communication-type receiver.

IT might be as well before discussing the present need for recruits to the Royal Naval Volunteer Wireless Reserve to review the history of the organization. Formed in 1932, as a result of consultations between Vice-Admiral J. W. S. Dorling (representing the Admiralty), H. Bevan-Swift, A. E. Watts and J. Clarricoats (R.S.G.B. representatives) and H. S. Pocock, it had a membership of 270 by 1938, when it was amalgamated with the Telegraphist Branch of the Royal Naval Volunteer Reserve, bringing the combined total to 381. In 1939 it was given its present title. During the war the reservists filled with distinction posts in the Signals Branch of the Navy, both afloat and ashore. In 1946 it was decided to reconstitute the Reserve, which now has a strength of some 600 ratings. Whilst this is in excess of the 1939 figure, it is well below the total strength allowed by the Admiralty—39 officers, 1,200 telegraphists and 240 electrical ratings for maintenance work.

The main object of the Reserve is to train telegraphists who, in an emergency, would fill the gap in the Fleet until the mobilized men had been trained for the task. Training is essentially operational rather than theoretical, although some basic theory is taught. Having reached the required standard of proficiency, a telegraphist may be lent transmitting and receiving equipment for use at home. He does not, however, have to pass the normal P.M.G. licence examination but is issued with a licence on the recommendation of his District Officer.

Each of the nine Districts into which the United Kingdom is arbitrarily divided for the purpose of the Reserve contains a number of training centres where regular instruction is given by full-time telegraphist instructors. Recruits must be between the ages of 17 and 45 and must sign on for five years. Training consists of sixteen hours' instruction per quarter, plus four periods of eight days' continuous training with the Navy during the five years. Young men liable for National Service, who join the R.N.V.W.R. and attain the requisite standard of proficiency, are certain of acceptance in the Navy for their period of service.

A bounty of £9 is paid to Reservists at the end of each year, plus a proficiency grant of up to £3 p.a. Travelling and training expenses are also paid, and those using Naval transmitting equipment at home are granted a maintenance allowance of £3 p.a.

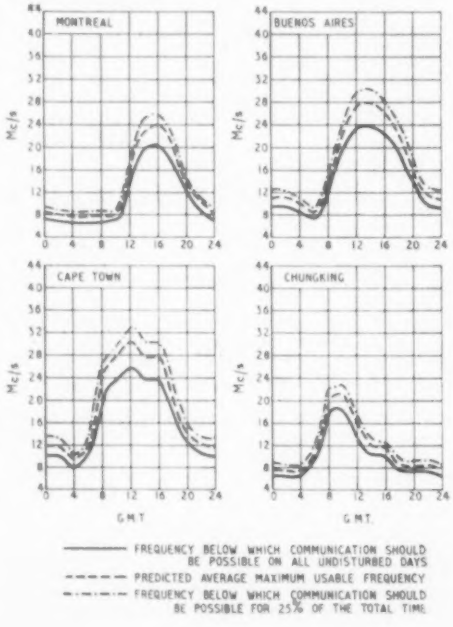
In conformity with modern practice, Reservists are taught touch-typing so that they can take down morse messages direct on to the typewriter. The Naval speed is 22 w.p.m.

Particulars of the Reserve, which now has thirty-nine training centres and units, are obtainable from the R.N.V.W.R., Queen Anne's Mansions, London, S.W.1.

Short-wave Conditions

Predictions for January

FROM this month the publication of the written matter on short-wave conditions will be discontinued, but the predictions will continue to be given in the form of four sets of curves, indicating the highest frequencies likely to be usable over four long-distance circuits from this country during the coming month. The curves, together with their caption, will be self-explanatory.


MONTREAL
BUENOS AIRES
CAPE TOWN
CHUNGKING
Mc/s
G.M.T.
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS
PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

Propagation of V.H.F. *via* Sporadic E

By T. W. BENNINGTON *

Analysis of Some European Data

THERE frequently form, within the normal E layer of the ionosphere, "patches" or "clouds" of abnormally dense ionization, which are capable of reflecting radio waves of frequencies much higher than those reflected by the E layer itself or, indeed, by any of the regular ionospheric layers. The patches take the form of thin sheets of ionization having an apparently quite limited geographical area. They are of a random and intermittent character, both as to the time and position of their occurrence and as to their ionization density, and, for this reason, are called "Sporadic E." Nevertheless, as will be seen later, Sporadic E does display marked diurnal and seasonal features in the frequency of its occurrence at any one geographical location.

Clouds of this nature are capable of reflecting radio waves, at oblique incidence, on frequencies frequently exceeding 30 Mc/s and on remote occasions extending up to 100 Mc/s, and they are thus capable of propagating over relatively long distances frequencies within the v.h.f. band, whose normal range is the limited one attained by the travel of the ground and tropospheric waves. It is thus apparent that if channel-sharing by stations working on frequencies in the v.h.f. band is established on the basis of the normal ranges, the services may at times be subject to mutual interference by waves travelling by way of Sporadic E. That is, perhaps, the most important consequence of the occurrence of Sporadic E, since, because of its nature, it cannot be relied upon to be of use in any *regular* radio communication service.

Transmission by way of Sporadic E is practically always confined to a one-hop mode owing to the remote possibility of its simultaneous existence with a high ionization density at the widely distributed geographical points necessary for multi-hop transmission. The maximum range by way of the medium is therefore about 1,400 miles, i.e., a one-hop mode via the E layer with the largest possible angle of incidence.

There are, in fact, three distinct *types* of Sporadic E, these being, apparently, due to widely different causative agencies. The first is the auroral-zone type, which was first investigated in detail by Appleton, Naismith and Ingram using observations taken at Tromsö in 1932-33.[1] Many observations by stations in high latitudes have since been made upon this type of Sporadic E, including some very recent ones at Kiruna, in the north of Sweden,[2] and from all these its characteristics are now fairly clear. It is closely associated with ionospheric and magnetic disturbances, and with auroral activity. Its occurrence has a maximum around midnight, as also, generally speaking, has its intensity, and it has a minimum centred around noon. It can, on occasions, reflect frequencies of up to 90 Mc/s.

The second—and most important—type of Sporadic E may be called the temperate-zone type, since it is the main feature of the sporadic ionization which is observed in mid-latitudes. It is to be noted, however, that the auroral type of Sporadic E sometimes spreads to these latitudes, whilst the temperate type is frequently observed in high latitudes, coexistent with the auroral type.[2] The temperate-zone type, however, displays markedly different characteristics from the auroral type. It has no relation to ionospheric or magnetic disturbances, it has a diurnal maximum around noon and is at a minimum at night, and a marked seasonal variation such as to give a large maximum at midsummer with a very low rate of occurrence during the winter. Because of the noon peak it has been suggested[2] that its primary causative agent may be the sun's ultra-violet radiation, whereas the auroral type, with its night-time maximum and its association with ionospheric storms, may be due to bombardment of the ionosphere by solar corpuscles.

The third type is observed only in low latitudes, but at present little seems to be known about it.

Temperature-zone Type

It is with the temperate-zone type of Sporadic E that the rest of this article will deal. The present writer has previously published an analysis of some Sporadic E measurements made in England during 1945, 46 and 47[3], giving the percentage of time during which propagation could be maintained by Sporadic E over a range of 1,400 miles. It should now be useful to analyse the measurements for 1948, 49 and 50, and to see whether the derived curves are similar to those for the previous years.

For this purpose the hourly measurements made at the Slough station of the Department of Scientific and Industrial Research have been mainly used.[4] Use has also been made of the published measurements made at Fraserburgh,[4] De Bilt,[5] Lindau,[6] Freiburg,[7] Domont and Poitiers.[8]

Sporadic E does not have a definite "critical" frequency, as do the regular ionospheric layers, but reflects waves above a certain frequency with a reflection coefficient which decreases with frequency, so that the highest reflected frequency observed depends, not only upon the density of the phenomenon, but also upon the power of the transmitter and the sensitivity of the receiver. Thus the observations made at different stations may not be strictly comparable, though those for any one station are, of course, indicative of the density of the observed Sporadic E, in terms of the reflected frequency. Because, however, of the considerable variation in the density of the phenomenon, the

* Engineering Division, B.B.C.

† References to be found at end of article.

average of the highest frequencies reflected would have little meaning, so it is better to make the analysis on some other basis. The best course seemed to be to examine the Slough measurements in order to find out the percentage of the total time that Sporadic E was observed each month. Since we are mainly interested in the propagation by Sporadic E of only the higher frequencies (30-300 Mc/s), it was considered better to ignore the lower frequency reflections recorded at vertical incidence, and to use only those greater than 5 Mc/s. Sporadic E capable of reflecting 5 Mc/s at vertical incidence would sustain propagation on about 26 Mc/s over 1,400 miles. So it is here considered only when capable of propagating waves on that or higher frequencies, the symbol fE_s indicating the highest frequency reflected at vertical incidence.

In Fig. 1 (a) are plotted the monthly rates of occurrence of Sporadic E for the years 1948, 1949 and 1950, in terms of the percentage of the total time during each month when it was present and capable of reflecting frequencies greater than 5 Mc/s at vertical incidence, as obtained from the hourly measurements made at Slough. Fig. 1 (b) gives the mean monthly distribution for the three years. During the winter and early spring, it will be seen that very little Sporadic E is recorded, the minimum being in February or March. From April to May there is a very rapid increase, a maximum occurs in June or July, and, following a somewhat less rapid decrease, low rates of occurrence are recorded from September onwards. The general variation in the occurrence of Sporadic E, as here shown, corresponds fairly well with that found for previous years, except that the September decrease is here more rapid. During the months September to April inclusive Sporadic E was present generally for less than 6 per cent of the total time, whilst during May to August inclusive it was generally present for 20 per cent or greater of the total time. These are the mean values—those for 1949 were often lower, whilst those for 1948 were exceptionally high. One could therefore say that,

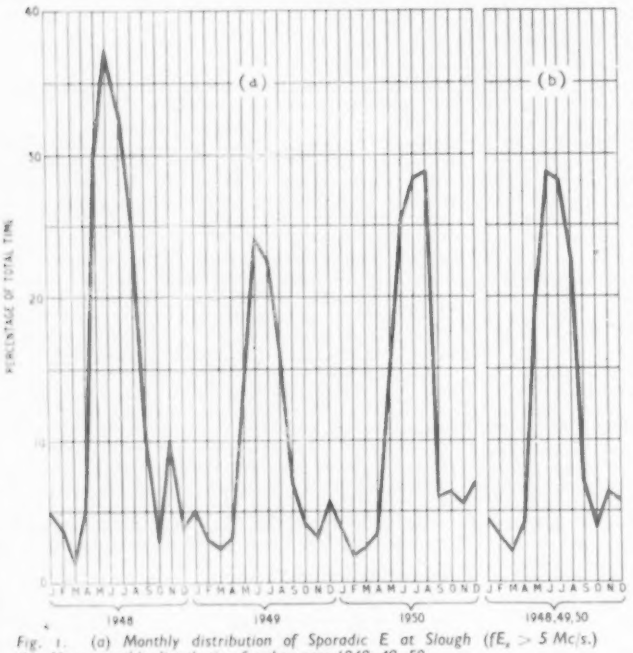


Fig. 1. (a) Monthly distribution of Sporadic E at Slough (fE_s > 5 Mc/s.) (b) Mean monthly distribution for the years 1948, 49, 50.

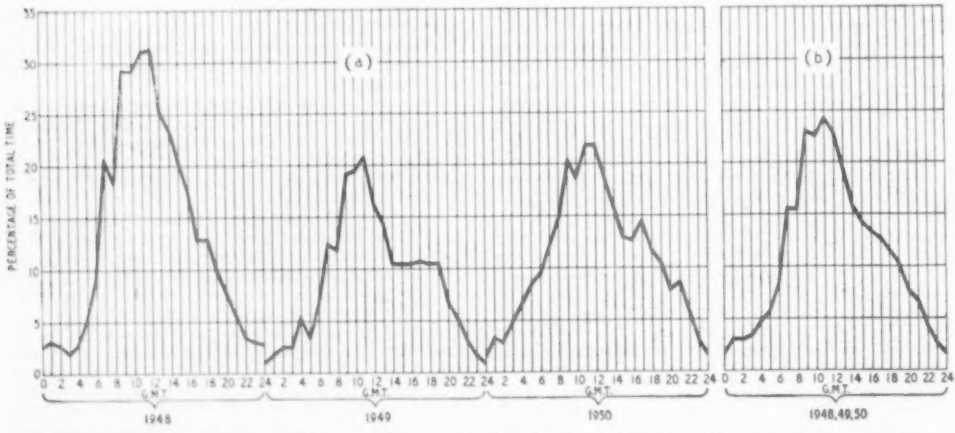


Fig. 2. (a) Mean annual 24-hour distribution of Sporadic E at Slough (fE_s > 5 Mc/s). (b) Mean 24-hour distribution during the period 1948, 49, 50.

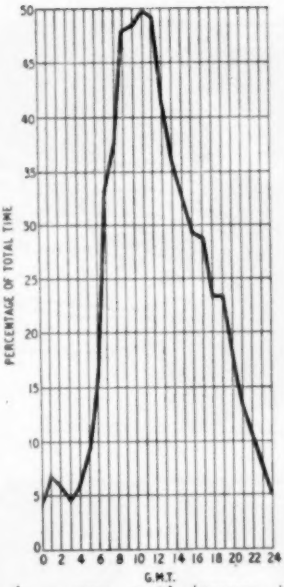


Fig. 3. Mean 24-hour distribution during the four months May-August, for the three years under consideration, 1948, 49, 50.

whilst Sporadic E capable of propagating frequencies of 26 Mc/s or higher may be present only occasionally from September to April, during the period May to August it is likely to be present for something like a quarter of the total time.

The diurnal variation in Sporadic E is shown in the graphs of Fig. 2, from which it is seen that minimum activity occurs during the night, that there is a very rapid increase in the early morning, a maximum centred near noon, and a rapid decrease thereafter. In the analysis for the years 1945/47[1] there was found a distinct tendency for a subsidiary peak to occur around sunset, and the recent Swedish measurements[2] indicate the same effect, though only during the months May/August. In the Slough measurements there are slight indications of it during 1949 and 1950, but, as Fig. 2(b) shows, it does not appear to be a prominent or settled feature of the diurnal variation. Whilst the curves of Fig. 2 (a) show as mean values for each year the percentage of the total time at each hour of the day when Sporadic E was observed and that of Fig. 2 (b) the mean values for the three years, none of them brings out the maximum proportions of Sporadic E, in terms of percentage of time. As the seasonal curves of Fig. 1 show, it is during the months May to August that Sporadic E is chiefly in evidence, and Fig. 3 is produced to show the mean diurnal distribution during those four months only for the period 1948/50. This curve shows an approximately 100 per cent. increase in the values, both by day and night, as compared with those given in Fig. 2(b). Again the subsidiary peak at sunset is absent. It is seen that, for several hours before and near noon, Sporadic E is present for roughly half of the total time during the summer. It is, therefore, of considerable importance in the propagation of frequencies in the v.h.f. band during those months, and, especially from the point of view of shared-channel interference. It remains to be seen, however, to what extent the propagation by Sporadic E is likely to deteriorate with increasing frequency.

Propagation Characteristics

Although, as has been said, *mean* values of Sporadic E highest reflected frequencies are largely meaningless because of the great and seemingly erratic variations in the incidence and intensity of the medium, yet some idea of its propagation potentialities for various

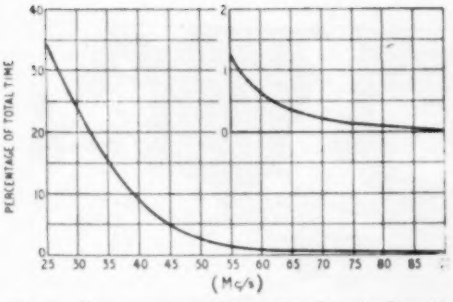


Fig. 4. Mean percentage of time when Sporadic E would sustain propagation over 1,400 miles during daytime in Summer months (May-August inclusive); 0600-2200 G.M.T.

frequencies was obtained in the following way. The recorded measurements were classified into frequency bands, each band being 1 Mc/s wide (>5 Mc/s, >6 Mc/s, etc.). Then the percentage of time during which Sporadic E existed with each band was established. Multiplying by the Sporadic E m.u.f. factor appropriate to 1400 miles converted the results into frequency bands which would have been propagated over this distance. It was decided to confine this examination to the periods when Sporadic E was present for more than 10 per cent of the total time, namely, from May to August inclusive (Fig. 1b), and from 0600 to 2200 G.M.T. (Fig. 3).

The results are plotted in Fig. 4, which gives the mean percentage of the total time, for the three years and for the summer months and hours of day mentioned, during which propagation could have been maintained by Sporadic E over a range of 1400 miles, plotted as a function of frequency. This curve is not very different from that obtained in the previous analysis for the years 1946 and 1947, so far as the highest frequencies are concerned, but the values for the lower frequencies are, in the present case, somewhat larger. It is seen that there is a very rapid decrease in the rate of incidence of Sporadic E capable of sustaining propagation over the distance considered, with increasing frequency. However the effect of the temperate-zone type of Sporadic E in long-distance propagation would appear to extend up to a frequency of about 88 Mc/s (occasionally even higher) during the summer months, though on frequencies above 55 Mc/s it may be considered to occur so infrequently as to be of little importance. It may be considered, therefore, that, from the shared channel point of view, stations working on frequencies between 30 and 55 Mc/s would be subject to a considerable amount of mutual long-distance interference during the summer months, whilst those operating in the 55 to 88-Mc/s band would suffer such interference only occasionally. Stations on frequencies above 100 Mc/s would rarely suffer such interference. This curve, now generally substantiated by an examination of measurements taken during more than five years, may, it would seem, be taken as being practically true for interference conditions in the v.h.f. band in the temperate zones.

It would, of course, be extremely interesting if one could obtain some idea of the geographical extent of Sporadic E clouds at any time, to see if they were subject to any systematic movement or "drift" and to learn something about the way in which they grow in ionization density. As has already been pointed out,

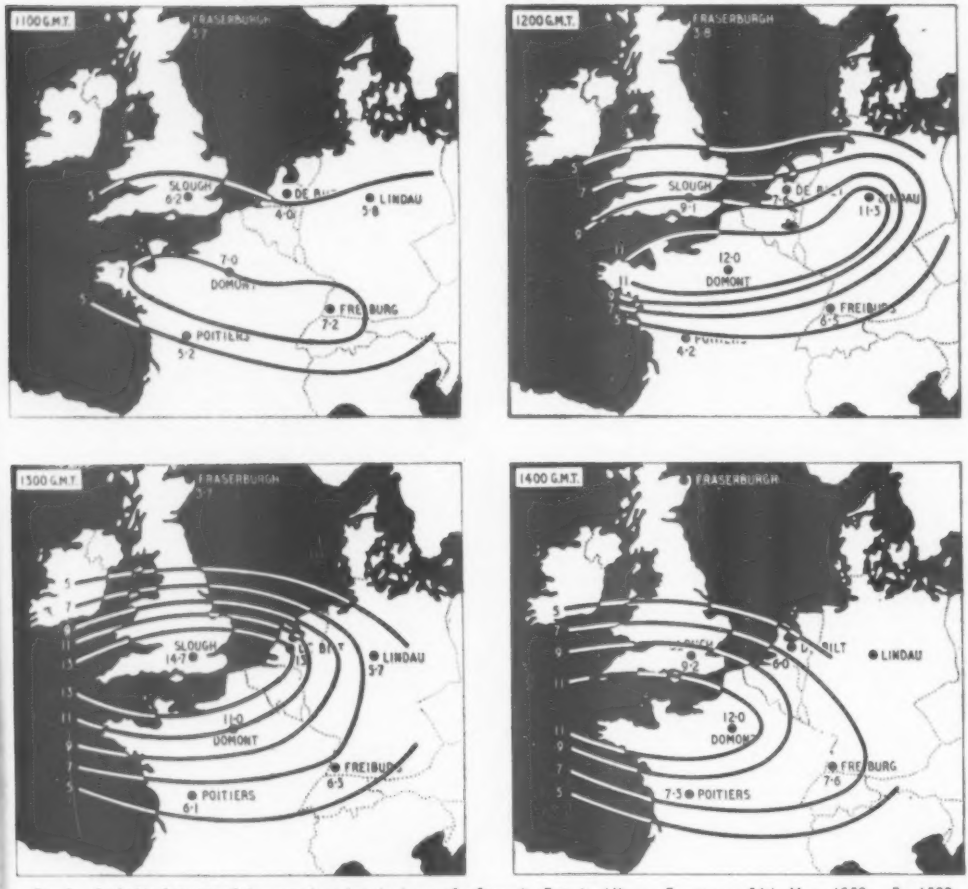


Fig. 5. Probable features of the growth and early decay of a Sporadic E "cloud" over Europe on 24th May, 1950. By 1500 G.M.T. it had decreased to approximately the density at 1100. The contours represent lines of equal vertical incidence fE_s.

intense Sporadic E has limited geographical area, but O. P. Ferrell[1] has shown that it can, even in an intense form, extend over an area of some 200,000 square miles. Using the Sporadic E reflections obtained by radio amateurs in the 50-54-Mc/s band as his basic data he located the approximate positions of Sporadic E "clouds" over the United States, deduced their density variations with time, and found that they drifted due west with a velocity of 130 metres per second in one case, and north and northwest with a velocity of 40 metres per second in another.

So far as is known no similar work has been done in Europe, although it is believed that attempts have been made to correlate the vertical incidence measurements made by different stations, both in Europe and America, with little success.

The records of the stations at Slough and Fraserburgh in Great Britain, De Bilt in Holland, Lindau and Freiburg in Germany and Domont and Poitiers in France were therefore examined to see whether there was any correspondence between their Sporadic E measurements taken at times when the phenomenon was being observed at one or other of the stations in an intense form.

The measurements at these stations are generally made at hourly intervals and, in order to obtain a synoptic picture for a given time, the measurements were compared for the same hour (G.M.T.). Unfortunately the measurements at Freiburg are made at intervals which are one half-hour different from those for the other stations, so some liberty was taken in assuming the measurements were made a half hour later. Symbols were allotted to Sporadic E vertical incidence measurements of highest reflected frequency lying within different frequency bands, and by setting out the results for different stations one above the other in diagrammatic form it could be seen whether there was any correspondence in their measurements. It was realized that the measurements from different stations are not *strictly* comparable, but, since the frequency bands were 2 Mc/s wide, it was hoped, at least, to detect whether intense Sporadic E was present simul-

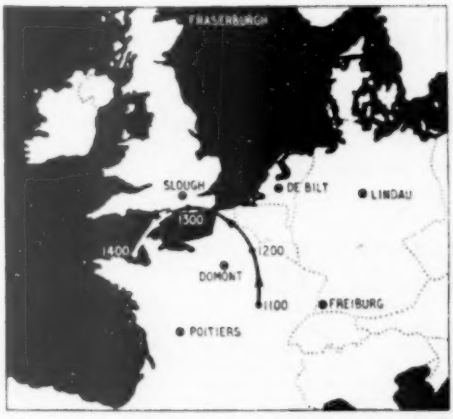


Fig. 6. Probable track of the "centre" of the Sporadic E "cloud" shown in Fig. 5.

taneously above different stations. As an example the results for the 23rd-25th May, 1950, may be mentioned. On 23rd May there was relatively little intense Sporadic E recorded, though the diagrams showed that there was a certain correspondence between some of the measurements at different stations. On the 24th and 25th, however, it became intense during certain hours, and the diagrams clearly showed that it was recorded in an intense form simultaneously, or with an indicated time lag, at different stations.

Selecting certain daily periods during which intense Sporadic E was present over a large part of Europe, it was then attempted to plot its contours in terms of highest frequency reflected, with a view to ascertaining its geographical extent, and its direction and velocity of movement or drift. The best result obtained is that shown in Fig. 5, which, it is thought, shows with rough accuracy, the growth and early decay of a Sporadic E "cloud" over Europe during 3 hours on 24th May, 1950. The contours are marked in terms of the highest frequency reflected at vertical incidence, so that the "outer" contour represents, at each hour, Sporadic E capable of propagating 26 Mc/s over 1400 miles, whilst the "inner" contour at 1300 G.M.T. (indicating the most intense Sporadic E recorded during the period shown) represents that capable of propagating 67.6 Mc/s over this distance.

At the time of its maximum density the "cloud" apparently covered an area of at least 500,000 square miles, although it is, of course, impossible to be at all certain about its area, because, for one reason, there were no measuring stations at its western boundaries. It is to be noted, in this connection, that in Fig. 5 the outer contours are for much less intense Sporadic E than was observed by Ferrell, but if the area enclosed by the 9 Mc/s contour is taken—and this would correspond roughly in intensity to the Sporadic E observed by him—then the area covered would be roughly similar to that observed in the U.S.A. In the present case, at 1300 G.M.T. the Sporadic E (inside the 5 Mc/s contour) would appear to have extended some 600 miles in a north-south direction and some 800 miles in an east-west direction. It should be pointed out that this must have been an *exceptionally* intense cloud, for such high vertical incidence measurements are not frequently recorded.

An attempt was made to trace the direction of movement and velocity of the "cloud" during the period under consideration. This was done by locating the approximate position of the "centre" of the cloud at each hour, and the result is plotted in Fig. 6. From this it would appear that the "drift" was at first northerly, and then north-westerly, and finally, after the decay of the cloud had begun, south-westerly. The total drift during the 3 hours under consideration was about 470 miles, giving a mean velocity of about 70 metres per second. The directions and velocity of drift are therefore similar to those observed by Ferrell. Similar directions of drift were deduced for other clouds of Sporadic E which were examined in the same way, though none of these was so intense as that in the example given.

It does seem possible, therefore, to trace the growth and movement of Sporadic E clouds from the vertical incidence measurements made at a number of stations. Much further work will, however, be necessary on this matter before any definite conclusions as to the real geographical extent, and the direction and velocity of movement of Sporadic E clouds can be drawn.

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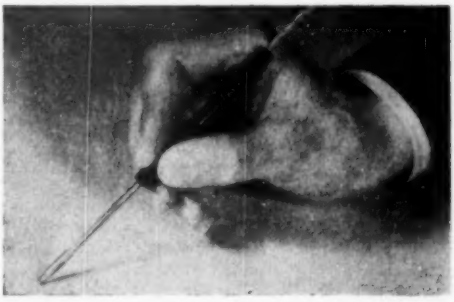
"SUB-MINIATURE" SOLDERING IRON

WORKING on the principle that the assembling of present-day "sub-miniature" equipment calls for special tools and appliances of appropriate size, Oryx Electrical Laboratories (BCM/ORYX, London, W.C.1) have produced a series of electrical soldering irons of exceptional smallness. Measuring under 6in in length and weighing about a quarter of an ounce, these irons are made in two basic types—with or without replaceable push-on bits. Ratings vary from 6V, 6W to 24V, 9W. A test shows the Oryx irons are capable of doing heavier work than that for which they are clearly designed; on light work temperature is well maintained in continuous use.

Oryx soldering iron (intermediate size bit) for wiring "sub-miniature" sets, hearing aids and other extra-light work.



V.H.F. BROADCASTING

B.B.C. Recommendations Based on Recent Tests

AFTER a long period of rumour, controversy and guesswork some concrete facts are now emerging regarding the proposed v.h.f. broadcasting service for this country. An article in the Autumn 1951 issue of *The B.B.C. Quarterly* gives an outline of the case for the establishment of a three-programme service in the frequency range 88-100 Mc/s, and the tests which have been made, both in the laboratory and in the field, to decide on the best method of modulation.

In view of the importance of keeping receiver costs low, only three systems of modulation have been investigated—a.m. (amplitude modulation), a.m.l. (amplitude modulation with a noise limiter incorporated in the receiver), and f.m. (frequency modulation). To quote the report: "Pulse modulation systems have also been considered, but are not thought to offer sufficient advantages for broadcasting to merit further consideration."

Signal Noise Ratio

As far as quality of reproduction is concerned there is little to choose between the alternatives considered, provided that in the case of a.m.l. a carefully designed limiter is employed. The criterion used in judging the relative merits of the systems has therefore been signal/noise ratio, and this has been studied both for background hiss and impulsive interference of the type caused by motor cars and some domestic appliances.

In the laboratory, f.m. has shown a 26db advantage over a.m. as far as background noise from receiver hiss is concerned. Under normal listening conditions, this advantage is confirmed by observation with a simple dipole aerial which shows that for background hiss to be classified as "perceptible" but not "disturbing," a signal field strength of 1,000 μV/m is necessary with a.m. or a.m.l. whereas with f.m. the corresponding figure is only 50 μV/m.

Impulsive interference, which is generally random in character, is more difficult to measure, and to get consistent results for comparison an artificial source giving repeated uniform impulses was used. The curves shown in Fig. 1 confirm theoretical predictions of the "improvement threshold" at unity signal/noise ratio with f.m., and for ratios greater than unity, f.m. shows a 25db superiority over a.m.

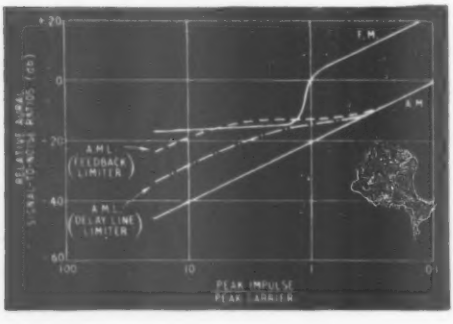
The field strength contours for Wrotham, which apply to either of the 20kW transmitters used at that station, are shown in Fig. 2. It will be appreciated that at 90 Mc/s these contours are average and that considerable local variations are possible, particularly in hilly or built-up areas.

In addition to these measurements of field strength the B.B.C. has asked the opinion, in the form of a questionnaire, of a number of listeners in all parts of the projected service area who were provided with a standard receiver of reasonable but not abnormally good specification, which could be switched at will to each of the three modulation methods under review. The results have been analysed and tabulated on the basis of a first-class service area in which the interference from 50 per cent of cars on a busy road 30 to 60ft from the receiver is imperceptible and of the remainder occasional cars may give rise to interference which is "slightly disturbing"; and a second-class area in which at least 50 per cent of cars is never graded as worse than "perceptible," though occasional cars may be graded as "disturbing." The approximate field strengths at the lower limit of these two areas and the corresponding ranges are given in the Table.

The report states that to cover the country using a.m. would require from three to four times the number of stations using f.m. Apart from the difficulty in obtaining agreement for the larger number of high masts, the increase in the cost of equipment, high-grade landlines, buildings and maintenance would be serious.

Whichever system of modulation is used, the necessity for common-channel working will have to be

Fig. 1. B.B.C. experimental results showing comparison of f.m., a.m. and a.m.l. from the point of view of impulsive interference.



TABLE

System	First-class Service Area		Second-class Service Area	
	Field-strength (mV/m)	Approx. range (Miles)	Field-strength (mV/m)	Approx. range (Miles)
f.m.	1	45	0.25	60
a.m.l.	3	35	1	50
a.m	10	25	3	35

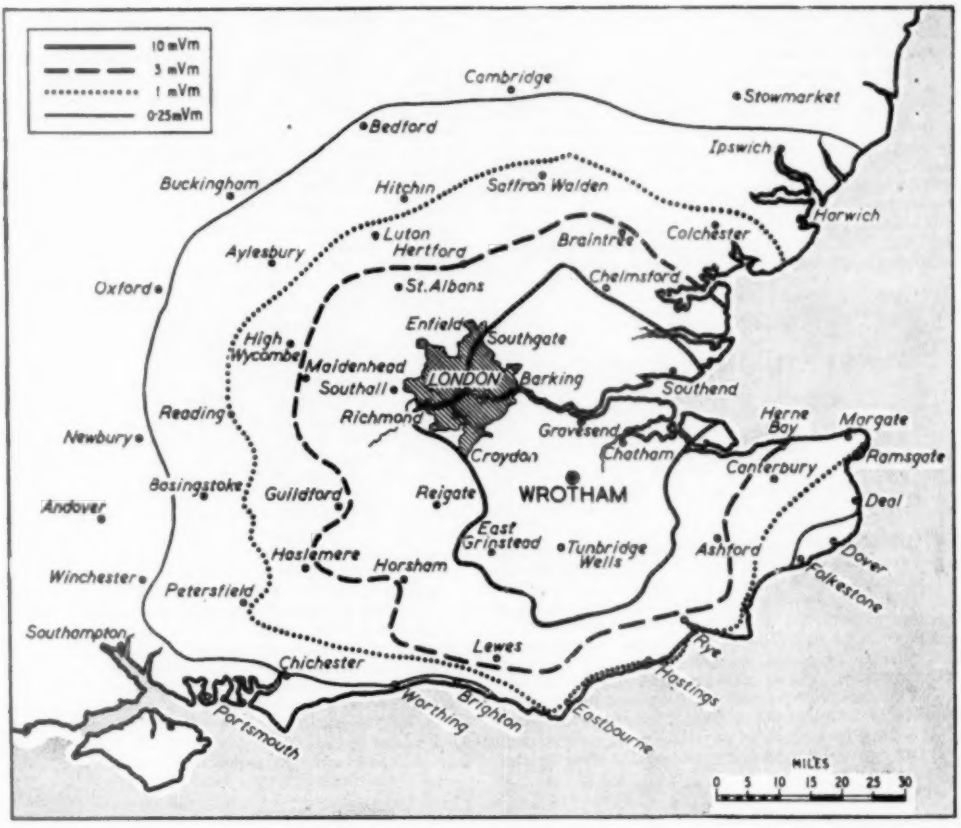


Fig. 2. Contour map of field strength from the Wrotham v.h.f. transmitter, based on measurements taken by the B.B.C.

faced. Close synchronization, as practised at medium frequencies, is not feasible at v.h.f. and the report discusses experiments to determine the possibilities of interference under freak tropospheric propagation conditions between distant stations with frequency differences from zero to 15 kc/s. The provisional national scheme will be planned to avoid interference on this score for all but 5 per cent of the time on those days in the year when propagation conditions are conducive to long-range transmission

The scheme will give a three-programme service to 87 per cent of the population of Gt. Britain and Northern Ireland under "first-class" conditions, and a "second-class" service (or better) to 96 per cent.

E.M.I. INSTITUTES

THE National Institute for the Blind recently announced that two of their blind trainees had completed the year's course in radio servicing at the E.M.I. Institutes and had secured first and second-class passes in the terminal examinations. Reference was made in our Earls Court Show report to the universal Avometer adapted to enable blind users to take a reading by touch. A signal generator was also adapted for the use of these two blind trainees, who took the normal course with the sighted students. Circuit diagrams and service manuals were prepared for them in Braille by the N.I.B.

This example of the training provided by E.M.I. Institutes must not be taken as typical, but it does serve to show the versatility of the organization in meeting a special need.

The college, in Pembridge Square, Notting Hill Gate, London, W.2, provides a variety of courses, ranging from three-week practical courses on radio and television servicing to a four-year course in electronic engineering. Between these two extremes lie a three-year telecommunications-engineering course and a one-year course covering the principles and practice of radio for servicemen. At the beginning of the

Autumn term there were 164 students taking the one-, three-, or four-year courses, and there are generally some twenty-five taking the short-term course.

While, of course, the parent company, E.M.I., Ltd., has a claim on the college, Prof. H. F. Trewman, M.A., the principal, has stressed that the college courses are open to any student. In addition to the college courses, which are under the direction of J. B. McMillan, M.A., B.Sc., the Institute also sponsors an extensive series of postal tuition courses. These are under the direction of P. T. V. Page, B.Sc., and are administered from 43, Grove Park Road, Chiswick, London, W.4. They include electronics, telecommunications engineering and draughtsmanship.

SOUND RECORDING ORGANIZATION

Work of the Association of Professional Recording Studios

THE high quality of reproduction now attainable in direct recording has created a widespread demand from musicians, amateur and professional, public speakers and others who use the medium as a means of self-expression and criticism, and from humbler folk who have learned the pleasure that permanent sound pictures of social gatherings and the voices of their growing children can give.

Under the stimulus of this demand a growing number of sound studios have opened in all parts of the country and their skill is being enlisted not only for domestic sound portraiture but also by the medical profession and many branches of scientific research.

It goes without saying that a successful recording studio must possess first-class technical equipment. It was appropriate, therefore, that the annual general meeting of the Association of Professional Recording Studios held this year in London on November 23rd should open with a discussion on "Amplifiers for Recording," which was prefaced by a résumé by H. J. Leak of the problems of applying feedback from the cutter head itself, and of some of the circuit arrangements which have proved reliable in use.

That technical excellence of the recording apparatus itself is only the first step in establishing a professional service was emphasized by Morris Levy, who spoke during the afternoon session on the factors contributing to the achievement of an atmosphere in which artists could give of their best.

Derek Faraday (vice-president) gave members an account of the work of the larger private studios engaged in recording complete programmes and features for broadcasting stations on the Continent, in the Dominions and the U.S.A.

In reviewing the work of the year H. L. Fletcher (chairman) emphasized the importance of corporate representation at the highest levels in all matters affecting the interests of recording studios. Valuable concessions in the matter of purchase tax had resulted from consultations with the Inland Revenue and representations had been made to the committee investigating the law of copyright regarding proposals which the Association considered inequitable. They had also maintained discussions on matters of mutual interest with the Musician's Union and the Mechanical Copyright Protection Society.

The general secretary of the Association (M. K. Howells, 14, Wynchgate, Harrow Weald, Middlesex), in his report, stated that the membership numbered 83 and that application for a certificate of incorporation of the Association had been made.

CORUNDITE CABLE TERMINATION

Pressurized "Corundite" termination for use on Telcon television transmitter coaxial feeder cables.

THE good electrical properties, exceptional mechanical strength, heat- and damp-resisting qualities of Corundite, the insulating material used in certain grades of K.L.G. sparking plugs, led to an investigation into its possible applications as a radio insulator. As a result, a range of connectors for hermetically sealed radio components was produced.

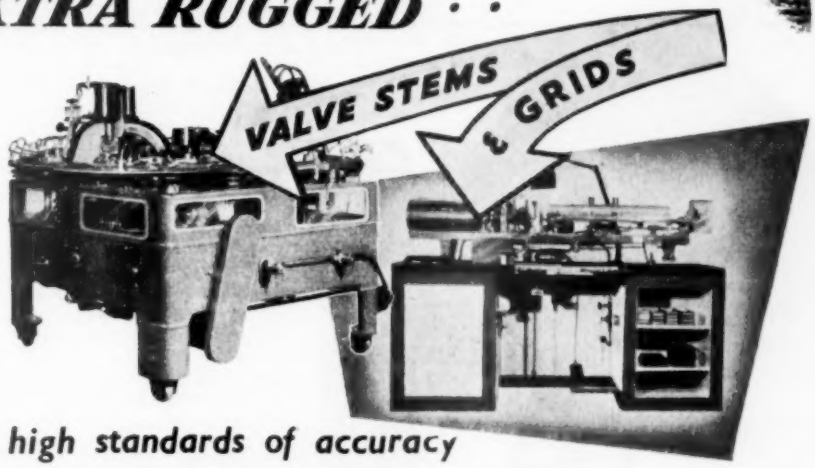
More recently, further work has been carried out at the instigation of the Telegraph Construction and Maintenance Company to ascertain its usefulness as the terminal connector and seal for certain types of Telcon pressurized coaxial cables used as feeders for television transmitters. These end-connectors have to withstand pressures up to 100 lb per square inch and must be suitable for tropical, temperate and arctic conditions.

The type of termination evolved by K.L.G. Sparking Plugs, Ltd., for this purpose is shown in the illustration. The steel body can be fixed to the sheath of the cable and sealed mechanically by any of the well-known methods, and it incorporates a Schrader air valve for introducing the gas into the cable.

The technique of joining the Corundite insulator, which, incidentally, is a fused aluminium-oxide substance, to the steel body and also of making a pressure-tight joint between centre conductor and insulator is similar to that used in the manufacture of K.L.G. sparking plugs, as the working requirements are closely related.

All Corundite termination seals are tested at 300 lb p.s.i. and the material appears to be quite capable of withstanding the high axial thrusts brought about by varying rates of expansion of cable and aerial elements.

FAST production of EXTRA RUGGED . .



to new high standards of accuracy

Demands from Industry and the Services for valves of a higher standard of accuracy and reliability have called for consideration of the machines employed in their manufacture. The result has been that our engineers have produced these two outstanding machines, both of which have been designed for the high speed production of valve components to a standard of accuracy and ruggedness which so far has not been equalled anywhere in the world.

These machines are already operating in Britain, U.S.A. and other parts of the world. In the **Brimar Valve** works at Footscray, Kent, England, they are engaged in the production of the high accuracy, extra-rugged **Brimar** TRUSTWORTHY Valves.

Please ask us for comprehensive details of these outstanding machines.

NOTE THESE IMPORTANT FEATURES

The MITCHELL-BRIMAR Stem Machine

Designed to meet the need for a British stem machine. Capable of producing extra rugged miniature and noval stems with a high degree of accuracy, the Mitchell-Brimar stem machine offers these outstanding features :—

Processes actually carried out on the machine

(a) Fine polishing of the glass disc.
(b) Bubble cushions raised in the glass around tower parts of pins.
(c) Hydrogen cleaning of the upper and tower parts of the pins.
(d) The setting of the correct radial compression strain in the glass disc.

Simple change-over permits production of B7G or B9G stems at will.
Production rate 700 per hour approx. with a loss of 2 per cent. max.
One operator only.
Accessible adjustments.
Easily and quickly dismantled.
Extremely robust construction.
Easy maintenance.
Automatic pin feed.
Automatic ejection of finished stem.

The BRIMAR Grid Winding Lathe

The Brimar Grid winding lathe has been developed in order to produce a finished grid **in one operation,** thus reducing costs and improving the product.

1. Constant **and** variable-pitch grid production.
2. Increased accuracy of grid lengths.
3. Elimination of "spring-back" when support wires are cut.
4. Maximum possible work can be done on grids **on or at the machine.** Thus it is possible to
   (a) Wind to the final profile wherever the required profile permits.
   (b) Hot-stretch the strip after winding, to straighten support wires.
   (c) Burn out during winding the loose turns between grids.
   (d) Automatically stake grids during winding.
   (e) Cold-stretch during the winding cycle, strips unsuitable for hot-stretching.
   (f) Chop grids accurately to length.
5. Unusual mechanical soundness.
6. Freely interchangeable parts.

MITCHELL STEM MACHINE BRIMAR

BRIMAR GRID LATHE

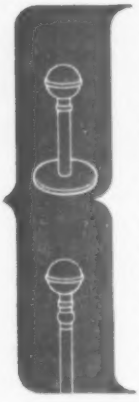
We regret that for the present our supplies of these machines must be for EXPORT ONLY

Standard Telephones and Cables Limited FOOTSCRAY · SIDCUP · KENT

acos

high fidelity MICROPHONES

FOR PUBLIC ADDRESS : RECORDING : AMATEUR RADIO



TYPE MIC 22

This model incorporates the famous **Acos** "Filtercel" insert giving extreme sensitivity and high fidelity. Response is substantially flat from 40-6,000 cps. The microphone is vibration and shock proof and is not affected by low frequency wind noises. Two alternative mountings are available for the MIC 22 head :

MIC 22-2 is supplied as a complete unit incorporating an attractive desk stand with cable side entry.

MIC 22-1 is for fitting to any British or American type standard floor stand and can also be used as a hand microphone.

PRICE £6 . 6 (*Either Model*)

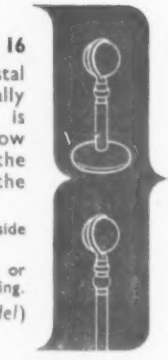
TYPE MIC 16

Incorporates the **Acos** Floating Crystal Sound Cell giving a response substantially flat from 30-10,000 cps. Performance is unaffected by vibration or shock and low frequency wind noises. As in the case of the MIC 22, two alternative mountings for the MIC 16 head are available :

MIC 16-2 is a complete desk stand unit with side cable entry.

MIC 16-1 is ready for fixing to either British or American type floor stands by means of a knurled ring.

PRICE £12 . 12 (*Either Model*)



COSMOCORD LIMITED ENFIELD, MIDDX.

P.S. *As you probably know, we make good pick-ups too, in large numbers. But even larger numbers of people want them. Although, therefore, we expect to be producing still more and still better pick-ups soon, just now we don't advertise pick-ups at all.*

AMATEUR RADIO SHOW

Larger-than-Usual Display of Home-constructed Equipment

THIS year the amateur radio exhibition organized by the Radio Society of Great Britain was more in the nature of a truly amateur show than usual as a vast amount of home-constructed equipment was on view.

Some of the credit for the fine appearance of the amateur exhibits must go to makers of components, such items as mains, modulation and audio transformers taking on a different appearance when neatly cased. The "potted" varieties shown by Woden well examplified this practice.

E.M.I. have always been staunch supporters of the amateur movement and their contribution to this exhibition took the form of a comprehensive display of special test and measuring equipment, a series of 465-kc/s i.f. transformers in large, medium and midget sizes, eliptical loudspeakers and some transformers.

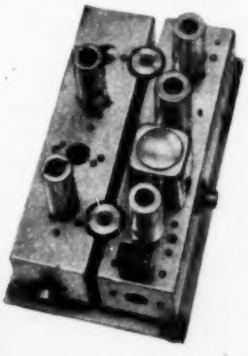
One of the worst nightmares of the transmitting amateur is the thought that he may be causing interference to local broadcast listening and to television. Many cases of interference are erroneously attributed to his activities; nevertheless it behoves all amateurs to make their equipment as TVI-proof as possible. To achieve this, complete screening is needed, as well as harmonic and spurious radiation filtering. Filters for the latter purpose were shown by Panda Radio, while all requirements for screened boxes and cabinets were catered for by Philpotts Metalworks.

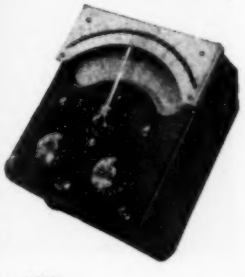
G.E.C. had a display of modern valves and a test set, but the exhibit that caught the eye on this stand

Right : Well-constructed crystal controlled two-metre converter shown by E. Yeomanson.

Bottom right : Model 7 Avometer modified for use by a blind person.

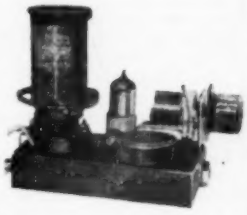
Below : New Acos hand crystal microphone Type Mic 30.

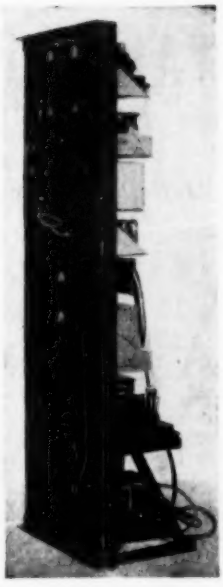




The largest single amateur exhibit for use on 160 and 2 metres—shown by S. Sharp (G3CKX).

One of the smallest crystal controlled transmitters shown by C. Cutts (G3HRC).





was a neat Yagi aerial constructed from light-alloy tubes and special castings. It embodies a balance to unbalance matching transformer.

Among the piezoelectric crystal devices shown by Cosmocord was a new hand-type microphone. Available in various colours it contains a double-crystal element, has a switch in the hand grip and is said to have a response sensibly flat up to 5 kc/s.

Prominent among the Avo exhibits was a Model 7 Avometer with a blind man's attachment consisting of an external indicator and Braille scales, a log one for ohms and a linear one for all other purposes. The external pointer is independent of the internal one and is moved by hand. When the two coincide a locking device comes into action and the slight resistance it imposes is easily determined by feel.

This report would be incomplete without some reference to the very fine displays staged by the Navy and the Royal Air Force.

The main interest on the Navy's stand was an exhibit showing some of the activities of the Royal Naval Volunteer Wireless Reserve, but there were also some of the latest communications receivers used by this Service.

The R.A.F. showed examples of the latest miniaturized radio and radar airborne equipments, also a research section where the present idea of miniaturization is made to look a little foolish. Comparisons were made between sub-assemblies now in use and how they will appear in the future when sub-miniaturization gets into its stride.

LIST OF EXHIBITORS

Automatic Coil Winder and Elect. Equip. Co., Ltd., Winder House, Douglas Street, Westminster, London, S.W.1.
Cosmocord, Ltd., Enfield, Middlesex.
E.M.I. Sales and Service, Ltd., Hayes, Middlesex.
English Electric, Ltd., Queen's House, Kingsway, London, W.C.2.
General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.
Panda Radio Co., 58, School Lane, Rochdale, Lancs.
E. J. Philpotts Metalworks, Ltd., Chapman Street, Loughborough
Salford Electrical Instruments, Ltd., Silk Street, Salford, 3.
Woden Transformer Co., Ltd., Moxley Road, Bilston, Staffs.

VALVE VOLTMETER

without calibration drift

"Infinite-input, Zero-output-resistance" Adaptor for use with any D.C. Voltmeter

By M. G. SCROGGIE, B.Sc., M.I.E.E.

ALTHOUGH much has been written about valve voltmeters (including at least one large book), so far as the writer is aware the subject has never been pursued to its logical conclusion. If we are to attempt to do so, we must consider what a valve voltmeter essentially is—a voltmeter in which the connection of the indicating instrument to the voltage to be measured is indirect, through an impedance-converting device, in order to eliminate as far as possible any loading effect on the source of the voltage.

It will be noticed that no mention has been made of a rectifier. That is because it is required only when measuring alternating voltages, and although most valve voltmeters include provision for doing this it is not a *sine qua non*. The essential element is the impedance converter, and it is the fact that valves can so readily be arranged to have a very high input impedance and relatively low output impedance that makes them so useful for that purpose. Some of the simpler types of valve voltmeter combine rectifying and impedance-converting functions in one valve, but the tendency nowadays is to separate them. The design of the rectifying portion has already received much publicity; in the following article it is intended to confine attention to the impedance converter, which is required for both alternating and direct voltages.

It will be assumed that the indicating instrument is a moving-coil meter, as experience has shown this to be the most generally convenient. Preferably it should not have to be highly sensitive, because microammeters are both expensive and easily damaged.

Clearly, then, the ideal converter would be one with infinite input impedance (for it would then have no effect at all on the voltage being measured), and zero output resistance (for then the whole of the meter circuit resistance could be wire-wound and highly constant). Although one of the main objects in valve voltmeter design has long been to make the output resistance as stable as possible, the results are usually quite a long way from the ideal zero. And it seems to be too often assumed that any valve worked with negative bias has negligible d.c. input conductance. The purpose of this article is, first, to show that where valve voltmeters are concerned this assumption is false, and, secondly, to explain how the output resistance can be made practically zero, so that the valve gear can be added to any ordinary moving-coil voltmeter, to adapt it for "infinite-impedance" measurements, without affecting its calibration. It follows that the calibration is unaffected by even large changes in the valve characteristics, because a variable factor multiplied by 0 remains constant at 0.

First, then, the matter of input conductance. The elementary book or instructor explains that current through a hard valve flows to the cathode only from a positive electrode; so as long as the grid is negative to cathode there is no grid current. For ordinary amplifier and receiver circuits, in which the resistance in series with the grid seldom exceeds 1MΩ, and nobody is any the worse for a slight shift of grid bias, that is a fair enough simplification. The trouble comes if one carries this early impression into work on measuring apparatus, where grid circuits may be much above 1MΩ and an unintended shift of even a small fraction of a volt is intolerable.

In the work which led to this article it was considered that a valve voltmeter in which the reading was noticeably affected by a grid circuit resistance of 20MΩ would be a poor thing. The fact that published valve voltmeter circuits showed rectifier load resistances of anything up to 100MΩ, followed by (as far as could

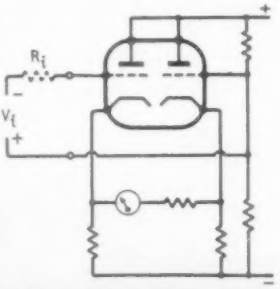


Fig. 1. Conventional valve voltmeter circuit.

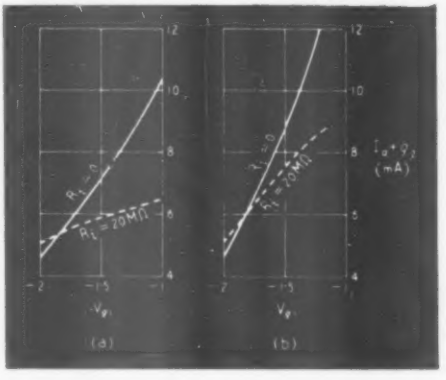


Fig. 2. Portions of characteristic curves of typical triode-connected samples of (a) EF50 and (b) SP61, with and without 20MΩ in series with the source of V_{i1}, showing unsuitability for measuring apparatus with high-resistance input circuit. Results with other types of high-slope valves were, in general, similar.

be seen) ordinary amplifier valves, suggested that there should not be much difficulty in this respect. But there was.

In the original trial circuits, the impedance converter or d.c. amplifier followed the present-day practice of using a twin triode somewhat as sketched in Fig. 1. The merit of this arrangement, of course, is that variations in supply voltage tend to affect both triodes equally, so that the zero setting is not appreciably affected. And the negative feedback due to using the valves as cathode followers has a stabilizing and scale-linearizing influence.

But just now we are considering the input circuit. To observe possible error due to input circuit resistance the effect on the reading of inserting high resistances at R, was noted. With the original valve, as little as 5MΩ caused a considerably larger change in reading than could be tolerated. A number of other valves were then tried—ancient and modern, separate and combined, triode and pentode. The results varied from indifferent to bad. Even glass-based valves of the EF50 type were not really satisfactory, nor was the valve holder responsible. It must be understood that the types tested were those considered reasonably suitable as cathode followers feeding a meter movement taking 1mA or so full scale. That is to say, they were chosen for a fairly large slope, not less than 3mA/V and preferably more, in the interests of an approach to the other clause of the ideal—zero output resistance. Figs. 2 (a) and (b) show the changes in anode current on inserting 20MΩ in series with the grid bias source, for typical samples of EF50 and SP61 valves respectively. (In fairness to the makers it must be said that such a grid resistance is far above the limit rating.) One notable feature is that with normal heater voltage the grid has to be as much as 1.5-2V negative to cut off grid current. With greater negative bias the error is of opposite sign, due apparently in the main to leakage from the anode. This was especially so with some of the twin-triodes. Assuming that the anode is at +100V, the leakage resistance to make the grid potential 0.02V more positive when 20MΩ is inserted in the grid lead is as high as 10^6MΩ; which shows that the demands of a valve voltmeter are not easy to meet, at any rate with mass-produced high-slope valves.

The conclusion from this was that to fulfil the input requirements it would be necessary to use a type of valve such as the EF37, which was known to have an extremely low input conductance, especially when run at low anode voltage and current and somewhat sub-normal heater voltage. It had been found possible to use such a valve to measure resistances up to well over a million megohms. Unfortunately these conditions of type and operation are diametrically opposed to those for low-resistance output. There seemed to be nothing for it but to use two pairs of valves —one for high-resistance input, coupled to the other for low-resistance output.

At this stage we can turn our attention to the output resistance. A valve with a slope of 5mA/V under operating conditions has an output resistance as a cathode follower of about 200Ω. In Fig. 1 there are two in series, making 400Ω. Assuming that the lowest range is 0-1V, and the meter is 0-1mA, and (for the moment) that there is a one-to-one coupling between input and output valve grids, the total resistance in the meter circuit on this range would have to be 1,000Ω. Of this, 400 would be in the valves, and therefore varying inversely as their slope. Although the effect of varying supply voltage on zero setting would largely be balanced out by the symmetrical valve arrangement, the effect on slope and consequently calibration would not, and stabilization would be essential to ensure accuracy under present-day electricity supply conditions. The gradual change in slope with age would also cause error, and valves could not be replaced without recalibration or adjustments of a fairly elaborate kind.

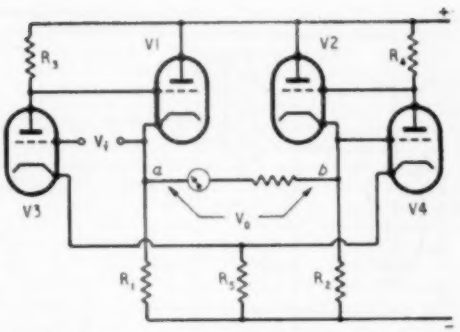


Fig. 3. Outline circuit of system having very high input resistance and almost zero output resistance. V_i is the voltage to be measured, and V_o (the output voltage) is less than 1% lower even when feeding a resistance as little as 500Ω.

So altogether we seem to be arriving at quite a complicated and expensive piece of apparatus, with a not very attractive performance. A voltmeter of any kind cannot really be considered satisfactory if a substantial part of its resistance on any range depends on the mutual conductance of a valve or valves. One would much prefer to see it all as wire.

Self-stabilizing Circuit

At this point it occurred to the writer that a stabilized power supply can easily be made to have an output resistance (R_o) of a few ohms, or, with a little care, a fraction of an ohm. The type of circuit in mind operates as a cathode follower with amplified feedback. Whereas the output resistance of a simple cathode follower is approximately $1/g_m$, this figure is divided by any voltage gain that is provided in the feedback loop. A valve of the EF37 class is excellent for providing voltage gain. Applying the voltage-stabilizer technique to a balanced valve-voltmeter circuit resulted in the arrangement shown in its simplest form in Fig. 3. V1 and V2 are the output valves. V3 and V4 are the high-input-resistance valves, connected so that their full gain in conjunction with V1 and V2 is fed back. With normal values, the difference between the output and input voltages V_o and V_i is of the order of only 1 per cent, so a d.c. voltmeter connected between *a* and *b* need not be recalibrated when used to measure voltages applied to the V_i terminals. As will be shown later it is an easy matter to eliminate even this small error.

V1 and V2, being used as cathode followers, are necessarily triode-connected whether or not they are in fact triodes. Seeing that R_o is now of the few-ohm order, the possible error in calibration due to variations in the characteristics of these valves is quite negligible, and if this consideration were the only one

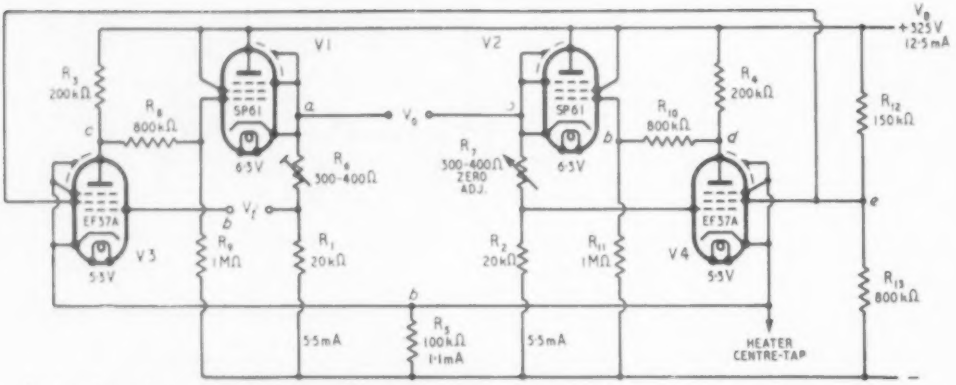


Fig. 4. Circuit diagram of the Fig. 3 type as finally evolved. The heaters of V3 and V4 are underrun to ensure low input conductance.

almost any type of valve could be plugged in without any readjustment or recalibration whatever, even on the lowest range. It is only when designing for the highest range that the characteristics are of much importance. As in designing voltage stabilizers for a large range of output voltage, one aims at high μ in conjunction with low g_m. Two SP61 valves are used in the writer's design, but an ECC33 twin triode can be substituted for them without making any noticeable difference except about 5 per cent. reduction in the highest measureable voltage.

Another advantage of the scheme is that almost any voltmeter can be connected between the cathodes; the full-scale current does not matter, within reason. The meter adopted actually has a full-scale current of just over 3mA. So most makes of multi-range test meters are suitable for use with this "electronic adaptor," which is so stable and error-free that a 5-inch scale can be used to advantage.

The range-changing switch on a multi-range voltmeter is operative when the adapter is in use, but only up to a certain limit depending on the circuit design and the supply voltage. It is here that the action of the circuit must be considered in greater detail.

A full mathematical analysis would probably just be confusing to most readers at this stage. The most helpful way to consider a problem of this kind, perhaps, is as an approximation, supplemented by a good idea of the factors controlling the departures from the approximate. For instance we know already that the output resistance of the system, as a source of d.c. for the meter, is (to a first approximation) zero; and that what resistance there actually is can be made more nearly zero by increasing the total voltage gain round the feedback loop. To a second approximation

$$R_0 \simeq \frac{2}{g_m m}$$

where g_m is the slope of V1 and m is the voltage gain of V3. The 2 comes in because V2 and V4 (assumed to be the same as V1 and V3) introduce a second equal resistance. The gain of a resistance-coupled valve of the EF37 type (including EF36, EF37A, and any similar) is not very large as a triode, but can easily be of the order of 100 in a pentode circuit. Taking $m = 100$ and $g_m = 0.006$A/V, we calculate that $R_0 = 3.35\,\Omega$, which is of the order realizable in practice.

Let us disregard initial voltages in Fig. 3 and take *a* as the zero point. The usual method of connecting a diode for alternating voltages makes V_i negative; so to begin with let us suppose $V_i = -1$. This negative voltage on the grid of V3 will reduce its anode current, raising the voltage of its anode and lowering that of its cathode. The raised anode voltage will make the grid of V1 (and hence its cathode) more positive, too. This positive movement, being fed back to the grid of V3, will tend to neutralize V_i. In fact, assuming for the moment that the cathode of V3 is somehow kept at a constant potential, and that the gain from the grid of V3 to the cathode of V1 is of the order of 100, only about -0.01V change in the grid potential of V3 would be needed to raise the cathode of V1 by 1 volt. In effect, then, introducing V_i does not lower the potential of its grid end appreciably; it raises its cathode end by practically the full amount. Although we know, therefore, that a change in grid-to-cathode potential necessarily occurs when a voltage V_i is applied, to a first approximation it is negligible compared with V_i.

Now we can consider the drop in cathode potential of V3. It is equivalent to a rise in the grid potential of V4, and tends to increase the anode current of V4. This tends to neutralize the change in common cathode potential of V3 and V4, and also to lower the grid (and consequently cathode) potential of V2. So while point *a* goes up, *b* goes down. And since, for the reasons given in connection with V1 and V3, the change in grid-to-cathode potential of V4 is negligible compared with V_i, it follows that the change in potential between the grids of V3 and V4 must also be relatively small. If one were to neglect it altogether then it would follow that V_i plus the output voltage V_0 would always have to be zero; in other words, the voltage reaching the meter would be opposite *and equal* to that applied at the "infinite resistance" input terminals. Which, as Euclid used to say, is what was to be done. The only difference between this ideal and the actual is of the order of 1 per cent caused by the fact that the gain of V3 and V4 is not quite infinite.

We see that when V_i is applied *a* must rise and *b* fall, but it is probably not obvious in what proportions. It is obvious that the movement cannot be

perfectly symmetrical, *b* falling by the same voltage that *a* rises, because if it were (with matched valves) there could be no change of current through the common cathode resistor of V3 and V4, and therefore V4 would receive no "signal." Which, as Euclid again would have said, is absurd. So it is clear that *b* must fall less than *a* rises, and the common cathode potential of V3 and V4 must fall by about the same amount as *b*. Analysis shows that the rise/fall ratio is approximately $1 + R_3/R_5$, but this result is not very reliable in practice because of complications such as maintenance of g_2 potential in V3 and V4.

These practical complications are now due to be considered. In the first place, Fig. 3 clearly would not work as it stands, because if all the valves had their appropriate grid biases the anode voltages of V3 and V4 would be negative. The first method to be tried for correcting this was to insert resistances of about 6kΩ in the positions R_6 and R_7 in Fig. 4. Fortunately a pentode can work down to a very low anode voltage; say 20. If V_i is always negative, then the initial anode voltage for V3 can be near its minimum, because its movement is always towards positive. The anode of V4 goes negative, but (with typical component values) only about one-third to one-quarter the extent, so if 50 or 60V is to be the top range, it is sufficient to give the anodes of V3 and V4 about 40V, which will leave some margin. But if both negative and positive voltages are to be measured this would not be enough.

The cathode resistor method was found unsatisfactory for at least two reasons. Firstly, if the meter terminals are kept at the cathodes, V_o becomes substantially greater than V_i and the original calibration does not hold; if they are not, the extra cathode resistors increase R_o substantially, and the calibration is again upset, though not so badly. Secondly, it was desired to tap off about − 1.5V from R_1 for ohmmeter purposes, and the slight change in the value of R_1 when the ohmmeter terminals are short-circuited shifts the zero slightly when V1 has a cathode resistor "above" R_1. So although it throws away a good deal of the voltage gain, a potential divider (R_8R_9 in Fig. 4) was tried, and worked better than expected.

Although cathode resistors in the positions R_6 and R_7 were abolished because of the disadvantages just mentioned, those disadvantages were due to the high value of resistance (about 6kΩ) required to provide V3 and V4 with anode voltage, rather than to their presence itself. In fact one of the disadvantages—the increase in V_o for a given V_i—can be turned into an advantage by choosing a much lower resistance for R_6 and R_7. By making R_6R_1 (and R_7R_2) equal to the proportionate error $(V_i - V_o)/V_i$ the discrepancy between V_o and V_i can be completely eliminated. And varying R_7R_8 is a convenient method of zero setting. The values required for this purpose are too low to cause appreciable trouble in the ohmmeter circuit.

Fig. 4 also shows the g_2 feed for V3 and V4 ($R_{12}R_{13}$).

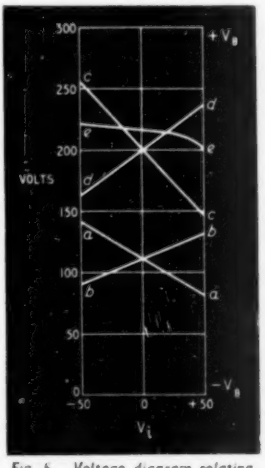


Fig. 5. Voltage diagram relating to Fig. 4, showing how the potentials of the parts marked a to e vary as V_i is varied from − 50V to + 50V. The differences between grid and cathode potentials of valves, being relatively small, are not shown.

Determining the component values in this circuit to ensure the desired top range, for the minimum supply voltage, is rather complicated, and would distend this article excessively if described in full and in general. But some idea of how a particular specification was arrived at may be helpful. The voltage diagram Fig. 5, obtained by measuring currents in the various leads over a range of positive and negative V_i and multiplying them by the appropriate resistances, is very illuminating. It is drawn for a supply voltage of 300, and shows the potentials of the correspondingly lettered points in Fig. 4. The differences in potential between the various parts marked *b*, which are only a few volts, are neglected in Fig. 5; and similarly for *a*. With the circuit values in Fig. 4, arrived at by several trials, we see that at $V_i = 0$ the anode voltage on V3 (V_{b2}) is about 90, rising to 165 at $V_i = -50$V and falling to 15 at + 50V. Obviously this is the limiting factor for measurement of positive voltage. The limit for negative voltage is set by V3 cutting off, which it would do when *c* reached 270V. The limit in both directions is thus set by V3 because it handles a greater amplitude than V4, so it is desirable to equalize the swing between these valves as much as possible. If, working on the formula $1 + R_3/R_5$, we reduce R_3 we reduce the gain, which is undesirable; so instead R_5 is made as large as practicable. Increasing it increases the current through V1 and V2 and ultimately restricts their swing. An incidental advantage of the potential dividers R_8R_9 and $R_{10}R_{11}$ is a tendency to equalize the swings; the approximate theoretical ratio is altered from $1 + R_3/R_5$ to $1 + p\,R'_3/R_5$, where p is the step-down ratio $R_9/(R_8 + R_9)$ and R'_3 is the resistance of R_3 in parallel with $R_8 + R_9$. Fig. 5, shows even better equality than theoretical, due presumably to the fact that this simple formula ignores screen-grid current. Note, incidentally, that the "push-pull" operation prevents the screen-grid voltage (V_{b2}) from varying as widely as it otherwise would.

Before completing the design it is necessary to check absence of grid current in V3 and V4 at the extremes of input, and if necessary modify component values or V_b if not satisfactory.

A suitable working margin must be be allowed above the maximum scale V_o, to allow for variations in mains voltage and valve characteristics. Beyond the working limits of V_i the system cuts off sharply and there is no further increase in current through the meter, which is thus automatically protected. It is advisable, however, to have it on its highest range when switching on and off, to avoid excessive transient unbalances while the heater temperatures are varying. The type of scale in the meter used made it convenient to have ranges of 0-1 5, 5, 15, and 50V. These were obtained in the usual way by series resistors. An extension of this procedure for higher ranges would have necessitated an unduly high supply voltage, so they were provided by means of an input potential

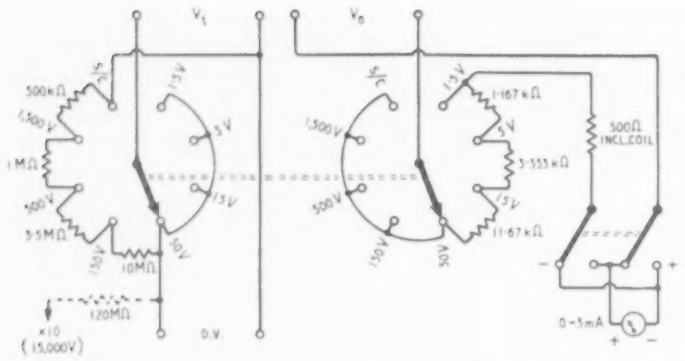


Fig. 6. Details of switching for d.v. (direct voltage) range and polarity, associated with the circuit of Fig. 4.

divider, which places 15MΩ (high-stability carbon) across the input terminals on all ranges. If desired this could be open-circuited on ranges lower than 150V. Fig. 6, which joins up with Fig. 4 at the V_i and V_o terminals, shows the range switching, including a reversing switch for reading positive voltages when required. The dotted multiplier is suggested for television voltages, etc., but should not be attempted by anyone inexperienced in high-voltage technique, as the chain of resistors totalling 120MΩ must be suitably mounted to avoid corona and leakage.

Resistance Measurements

A valuable feature of a valve voltmeter is the ease with which wide-range ohmmeter facilities can be incorporated. Fig. 7 shows how this was done in the present instance. The arrow marked D.V. leads to the arm of the range switch shown in Fig. 6, the resistance measuring components being cut out in the most clockwise position of the switch above. It is possible to combine the two switches in one, but it would have to be provided with rather a large number of ways. The values in Fig. 7 are based on 5.5mA through R_1, with readings taken on the −1.5V range. This voltage is tapped off R_1 273Ω from the top, and the 731Ω shown in Fig. 7 is the amount required to bring it up to 1kΩ (allowing for the rest of R_1 in parallel) to constitute the lowest resistance standard. The other standards are 10kΩ, 100kΩ and 1MΩ. The resistance to be measured is connected to the R_x terminals and forms with the selected standard a potential divider, so the resistance scale is of the usual ohmmeter type in which mid-scale reading corresponds to R_x equal to the standard.

Satisfactory readings are given from 100Ω to 10MΩ, with rough indications at 10Ω and 100MΩ. An additional facility is shown for testing insulation: a tapping at −78V in conjunction with 1MΩ across the V_i terminals, giving a minimum reading (at full-scale) with 50MΩ applied to the "Ins." terminals. A separate scale is, of course, necessary for this range. For insulation measurements three termimals are available, for employing the usual guard ring technique to exclude effects due to undesired leakage paths. Satisfactory readings are given up to 1000MΩ, and an indication at 5,000MΩ. The tapping is at 78V to allow for the full-scale drop of 1.5V across the standard, 75V across the 50MΩ, and 1.5V across a safety 1MΩ at the tapping. This last prevents the greater part of R_1 being short-circuited but does not prevent the pointer being driven off the scale, so before using this range a test should be made on the 1MΩ range.

Accuracy of the ohmmeter readings depends on constancy of the current through R_1. Ideally V_B should be stabilized, but since the current can be checked at any time by open-circuiting the R_x terminals it was decided to adjust V_B by hand, leaving enough margin to give full-scale with bottom-limit mains voltage.

Finally, a few data on performance. In spite of half the gain of V3 and V4 being thrown away by the potential divider, the total output resistance is only 4Ω, so that even on the lowest range and with a meter taking as much as 3mA full-scale, V_o is only 0.8 per cent less than V_i, and as we have seen this small error is eliminated by R_6 and R_7. A 10 per cent drop in V_B produces a barely perceptible (about 0.004V) shift of zero, and no perceptible change in calibration. A 10 per cent drop in heater voltage produces 0.01V zero shift and no perceptible change in calibration. Even the drastic test of connecting a second SP61 in parallel with V1 was equally satisfactory. The characteristics of V3 and V4 are much more influential; doubling V1 shifted the zero 0.61V, but when this was taken up on the zero adjustment the lowest-range calibration was again not perceptibly altered. In practice the change in characteristics of V3 and V4 even over a long period is likely to be small, and certainly not more than a very small fraction as drastic as this test. Experience so far has shown that even with ordinary carbon resistors, provided that they are conservatively rated and kept away from the heat of the valves, the zero is remarkably stable; but high-stability or wire-wound resistors are to be preferred for the more critical values.

It is hoped at a later date to describe the arrangements for measuring alternating voltage.

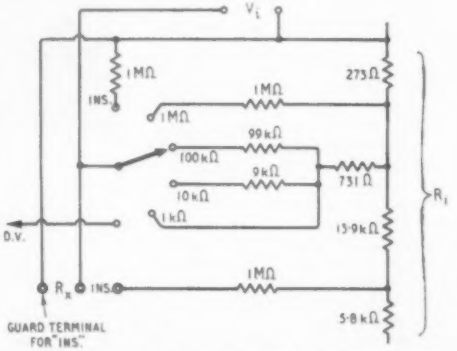


Fig. 7. Details of ohmmeter and insulation testing arrangements associated with Fig. 4.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Earls Court Television

YOUR correspondent, I. G. Benbough (December, 1951, issue) has, I venture to suggest, missed the main purpose behind the demonstrations of television at the Earls Court Radio Show. All exhibitions, whether of a technical nature or otherwise, try as a rule to show the various products to the best advantage in order to create that interest in the customer which may in this case lead subsequently to his buying a television receiver.

The pictures shown were therefore the best that could be produced within the limits of a 405-line system transmitted by radio and subsequently relayed throughout the exhibition by cable. It is to this end that the signal level was kept at 1 mV ± 3 db at the 70-ohm outlet and extraordinary precautions were taken to safeguard it from interference of all kinds. I suggest that few, if any, would-be purchasers of television receivers neglect to go and see the receiver of their choice operating under reception conditions near their home, especially since they would in most cases be buying it through their radio dealer.

If Mr. Benbough's suggestion were adopted, who is to say how much degration of picture by noise should be allowed? Those in quiet districts near the transmitter, of whom there are many, would undoubtedly regard any such interference as excessive, while those in the "fringe" would find it insufficient. Further, why stop at aeroplane effect and motor car ignition; why not some diathermy interference for good measure?

In my view, the signal fed to "Television Avenue" should be as good or better than that to which the British domestic set will do justice, always remembering that British television at such times comes under the critical eye of many who have never seen it before, both in this country and from overseas.

The demonstration and proper interpretation of the other points of a television receiver should be the job of the dealer who sells it, leaving to the Radio Show, as always, the creation of television interest.

Woking, Surrey. R. W. ADDIE.

Two-triode R.F.?

I HAVE reason to believe a number of your readers, besides myself, tried out the two-triode r.f. amplifier circuit in one form or another and were impressed by the high quality and stability obtained. The designer of the original *Wireless World* Q.A. Receiver stated in 1935, I believe, that the efficiency of a stage of two-triode amplification was virtually governed by the inter-electrode capacitance of the valves employed, and I have often wondered whether, with the tremendous advance in valve design since then, it might be profitable to investigate anew the possibilities of this circuit. The main objection to the original receiver—lack of selectivity—can be met to some extent by the use of the negative-feedback anode bend detector (not developed by 1935). Might it be possible, also, to use two stages of such amplification employing double-triode valves?

It would be interesting to have the opinion of other readers on whether the two-triode circuit is dead and gone for ever or can with advantage be resuscitated.

Caterham, Surrey. DOUGLAS A. FINCH.

"Universal Meter Shunt"

THE statement in your July issue that "to eliminate temperature error it is essential for the movement to have a swamp of Eureka or other low-temperature-coefficient wire in series with it" is true for most ordinary single shunted meters, but needs a little qualifying when applied to universal shunts.

It should have been made clear that the temperature error of a shunted meter depends not on the movement-to-swamp ratio but on the ratio between the movement and the total non-varying resistance in parallel with it. Therefore, in cases where the lowest range of a universal shunt exceeds the movement by a factor of less than 2, i.e., the total shunt resistance is greater than the movement, an appreciable amount of compensation is already present even without swamp. On a rise of temperature, the shunt develops a higher voltage drop by accepting the current which the meter refuses, and *vice versa*.

It is also a fact, not perhaps immediately obvious, that for a given temperature change the error of a universally shunted meter is the same percentage of the reading no matter where the input takes place: on the lowest possible range, i.e., directly across the movement terminals, or on the highest range, when most of the shunt is acting as swamp.

Those of your readers who wish to make the best practical use of the information contained in the article should, therefore, take the total resistance of the universal shunt they intend using into consideration in assessing the necessity or otherwise of swamp.

High Wycombe, Bucks. T. H. FRANCIS.

Units of Capacitance

THE issue raised in your columns of a more convenient sub-unit of capacitance seems to have been brought to a satisfactory conclusion by V. J. de Grijs (November, 1951, issue), who points out that the nano-farad (nF) for 10^{-9} farad is already in use in Central Europe and Indonesia. I therefore disown the "lillifarad" and from now on shall be relieved to write every capacitance above 820 pF and below 1 μF in nano-farads.

I should imagine our capacitor manufacturers will be delighted to avoid printing rows of noughts and illegible decimal points on their products. Whichever of them gets in first with an announcement that they will adopt this simplification will earn much goodwill.

Incidentally, it is an interesting commentary on the current recasting of world relations that the lead comes from Indonesia. Perhaps Mr. de Grijs would return the compliment by abandoning milliard for 10^9 in favour of the widely used billion of 10^9, since the initial letter of milliard is going to be confused with those of mega, milli and micro when abbreviated. V. MAYES.

Prestwich, Manchester.

More New Units

THE suggestions to adopt new prefixes, "nano" and "pico" for small capacitance values, would permit any value to be expressed as a whole number, thus reducing the possibility of mistake in the position of the all-important decimal point.

As an aid to the rapid calculation of the effect of a given capacitance in a circuit, a small unit of susceptance is required, since the capacitance becomes, in many cases, an "unwanted" but inevitable shunt element in a circuit. A convenient unit for dealing with the relative shunting effect is the micro-mho, conveniently debased to "jumbo," the "j" indicating that it is a susceptance and not a conductance. Thus a capacitor has, at a given frequency, $=C \times 10^6$ "jumbos" with the advantages of working in whole numbers, and of dealing with the two possible variables f and C in direct proportion.

Using the symbol "J" for this unit, a 10-pF capacitor possesses 62.8J at 1 Mc/s and at any other frequency, say 41.5 Mc/s, the susceptance becomes 41.5×62.8 or 2.6kJ. The "J" itself includes the ill-used prefix "μ."

Resistor values invariably yield a whole number if the conductance, 1/R, is expressed in μmhos; thus the relative disturbing effect of the capacitor can easily be estimated. Incidentally, the admittance of this parallel combination $Y = G + J$ ("umbos" plus "jumbos"?) is the vector sum of both (in μmhos).

Another "new" unit for comparing the overall performance of a device such as an oscillator, amplifier or receiver is available if the ratio of signal/noise is generalized into "wanted/unwanted" ratio, the wanted part being the signal voltage but the unwanted part to include *all* the disturbing voltages. The ratio then becomes a measure of the goodness factor of the device and can conveniently be expressed in db, i.e., the goodness factor = $20\log V/\sqrt{v_1^2+v_2^2+v_3^2+\ldots}$ where V is the r.m.s. value of signal, v_1, v_2 and v_3 being the r.m.s. values of hum, noise and distortion, so that the denominator represents the r.m.s. value of all the unwanted voltages in the output of the device.

Thus an oscillator with a hum content of 60db down, noise 60db down, and distortion of 0.1 per cent (also 60db down) would have a goodness factor of +55.4db, showing that the required signal exceeds the combined disturbing effect by this ratio. This method gives a useful figure for comparison purposes.

When dealing with the response/frequency characteristics of a device the only available unit of frequency ratio is the "octave" or eight-note ratio which is 2:1 in frequency. Much larger and very much smaller frequency ratios are commonly considered and a new unit of frequency ratio called the "decave" might be used. I decave (symbol D) would correspond to a frequency ratio of 10:1 so that the number of decaves in a given frequency spectrum = $\log_{10} f_2/f_1$.

The octave then corresponds to 0.3D so that the older unit could still be used.

For very small frequency ratios, the value of 0.001D or 1mD corresponds to the frequency ratio due to 0.012 per cent frequency change, i.e., 1.2 parts in 10^4.

This method of dealing with the log of the frequency ratio simplifies calculation and keeps it in line with the usual method of plotting response curves on log/linear graph paper.

Finally, in lighter vein, there is the O/P ratio of a radio or television set. This is the ratio of Ostentation, judged by the external appearance, to the Performance judged, of course, from the results. It is a very subjective factor found by giving each of the two qualities a mark out of ten and comparing the two. In these days of austerity few radio or radio-cum-television sets seem to have an O/P ratio in excess of unity.

E. McEWAN REID.

Sanderstead, Surrey.

Safer A.C./D.C. Sets

THE trend of thought on a.c./d.c. techniques appears to be going slightly astray these days. Thus, the argument for a "live" chassis in a broadcast or television receiver is that this dispenses with a bulky and expensive mains transformer.

The other aspect of the matter seems to have escaped the notice of manufacturers. I refer to the method agreed by technicians to prevent common paths and coupling between stages in a receiver—the common earth per stage. It is even more important to carry out this practice in television receivers with the high frequencies involved. If we keep to this beneficial layout a normal commercial receiver would require approximately five earthing tags, and in a television receiver about 20. Is there any reason why these earthing tags should not be insulated from the chassis at a cost of a few pence to the manufacturers? The chassis could then be earthed in a normal manner, and I am sure this practice would provide a strong selling point for the receiver, particularly in view of the danger which the public now knows exists.

An interesting variation of this train of thought is for a spare insulated tag to be provided on valveholders for use as a common earth, which is particularly easy to arrange on the B7G base.

Perhaps fellow readers can point out the fallacy in the above arguments.

C. E. THORN.

Newcastle-on-Tyne.

Hope for AIRMET?

AS a solution to the problem of finding a channel for AIRMET broadcasts, would it be possible to employ existing navigational aid transmitters? The modulation could be restricted in depth, frequency and time duration, as necessary, to prevent interference with the navigational facilities.

G. F. JOHNSON.

Welling, Kent.

"Modifying 'Surplus' Meters"

THERE exists a hazard to the health of many of your readers. Since the publication of the above article (September, 1951, issue), this hazard has probably reached a much greater section of the community. It is one of radio activity.

Many aircraft instruments are fitted with luminous dials activated by radium compounds having strengths several hundred times that considered a safe working tolerance at atomic energy research establishments. If a dust particle from the luminous paint on these instruments were accidentally inhaled, it might become lodged in the body and serve to shorten the life of the unsuspecting experimenter.

R. J. ELLIS.

Aldermaston, Berks.

[We understand that the radiation from the paint on the Type 3 (10Q/4) meter exceeds the safe working tolerance and might be injurious to anybody exposed to it for long periods. With the glass front on, however, the meter is quite safe as the radiation consists mainly of beta rays which have low penetrating power. A particle of the material inhaled or swallowed would definitely be dangerous, so we advise readers to work on the meter in the open air, or with a mask over the nose and mouth, and to be particularly careful about washing their hands before eating anything.—ED.]

Oval Spot?

WITH the present tendency leaning towards bigger television tubes and consequent line-spacing problems, it occurred to me that tube manufacturers could deliberately introduce astigmatic construction. By this means the spot could easily be made oval in shape, and by polarizing this in a vertical sense spot-wobbling, and the effect of viewing through a venetian blind, would be obviated. I should be interested in the B.V.A. reaction to this suggestion.

A. S. TORRANCE.

London, W.1.

Tinning Litz Wire

I HAVE noticed on several occasions reluctance on the part of radio technicians to use Litz stranded wire, whether covered with silk or enamel, owing to the difficulty of obtaining an absolutely perfectly tinned joint on all the strands.

Readers may be interested in a method which I have used since 1934. Double the wire back on itself, and give it half a twist, to keep it together. Then heat it in a spirit-lamp flame until it is red hot and, while hot, immerse in methylated spirits.

It will be found that after a little practice the wire comes out bright and shiny and completely free from any oxide —or even carbon from the burnt silk or enamel. All that needs to be done then is to apply a small amount of good quality soldering paste and tin with a clean iron.

F. TURTON.

Worthing, Sussex.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Christmas and "Ghost" Stories

A Happy New Year to all our readers, particularly to those who are enjoying a television New Year for the first time. Most of these will be in the north receiving Holme Moss. We hope there weren't too many "ghost" stories over the Christmas holidays.

At the time of writing this, the "Belling-Lee" Mobile Research Unit is setting out for Yorkshire to see if the engineers on board can evoke some technique to assist the ghost ridden viewer.

The new "Belling-Lee" Mobile Research Unit.

Our Television Conventions

During October we met 400 Radio Dealers, Service Engineers and Press in Manchester and 300 in Liverpool. As "ghosts" were the main topic of conversation, it was decided that the search for a remedy should take precedence over the field strength survey of the Holme Moss "fringe" areas.

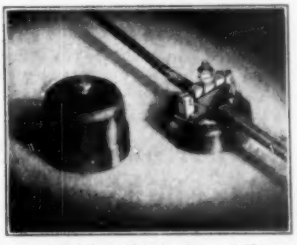
A number of people at both meetings asked if they could have reprints of the "Belling-Lee" page, which explained how to obtain the last ounce when viewing in "fringe" areas. The appropriate page is dated December 1950, and copies will be sent to any applicant. Incidentally a limited number of reprints are taken of all pages and will be sent to anyone who has lost his original copy.

By the time you are reading this, we will have met nearly a thousand Scottish Radio Engineers in Conventions held in December, at Edinburgh, Glasgow, and Dundee.

Lightning

Recent notices in the Press suggest that there is a measure of risk of television aerials being struck by lightning. One paper headed a notice in bold type, "Television aerials attract lightning." In fact, nobody would dispute that one is in far greater danger of an accident in going out to post a letter. If there was any significant danger to property, the insurance companies would not be slow in adding a shilling or two to the normal householders comprehensive premium. Each "Belling-Lee" aerial carries an insurance against damage by lightning and this is passed on to the ultimate user. During the past sixteen years, well over a million television aerials and "Skyrods" have been sold by "Belling-Lee" and erected, but there have only been five claims for damage by lightning brought to our notice, and in no case was damage done to the fabric of the house. In the same period many thousands of buildings without television aerials have been struck and damaged.

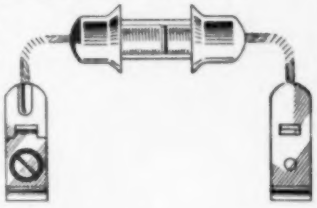
When lightning conductors are fitted to a high building, the conductors are generally of very heavy copper strip about 1½ inches wide and ⅛ inch thick. Cost of labour and material would be many more times that of a television receiver and its aerial. Such buildings are not immune and if the lightning charge is heavy, the copper will melt, but generally the copper is heavy enough to carry the charge. In the case of a television aerial, if the aerial is struck, the feeder



"Belling-Lee" Lightning Arrester L.376

(lead-in) generally disappears. It is instantaneously melted, and the charge follows the path of the metallic vapour. If the aerial system is not fitted with an outside spark-gap the receiver may be damaged, but that is all. While the presence of an outside gap might protect the receiver, we could not guarantee that it would under all circumstances.

The rising column of smoke or even air, issuing from a chimney is more conductive than the normal air surrounding the roof. The



"Belling-Lee" Lightning Arrester L.350

influence of that smoke or air is greater than any aerial, and if a static or lightning charge chooses to go to earth in the vicinity, it will follow down that conductive air column and probably shatter the chimney, and perhaps destroy the fireplace on the way. In any case, the damage would be much more serious than if a television aerial was struck.

Interference: New Post Office Procedure

In future if a licence holder for broadcast or television reception complains to the Post Office about interference, he will be sent a booklet that tells him in very simple language, how to test, to ensure that the help of the Post Office is really necessary, and that the trouble is not caused by a faulty receiver or an inefficient aerial. The analysis of years of work, shows that a third of the cases investigated come into these categories; thus taking up a third of the staff and effort, which otherwise would have been available for the tracing and suppression of bona-fide interference.

If it has been up for more than a year

Has your aerial been serviced this season? It is usual to have it done before the winter sets in properly. Just a routine check-up and a coat of paint all over, except over the insulators. Any paint will do; we suggest white or grey. A new aerial looks white with the sun shining on it. Don't forget the lashings and bracket. If you don't have it done now, and you are prepared to risk another winter, make a note to have it done the next time the house is being painted, or the roof repaired, or any time there are men with ladders about the place.

Written 29th November 1951

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New Charter

AS was anticipated, the Government has decided to renew for a period of six months the B.B.C. Charter, which, granted in January, 1947, terminates on December 31st. This will enable the Government to have further time to consider its policy in relation to the recommendations of the Beveridge Committee and the late Government's White Paper.

The new Charter and Licence will incorporate the provisions of the existing documents except for a change in the financial arrangements. The late Government's proposal, that the B.B.C. should receive 85 per cent of the net licence revenue—i.e., after deduction of 7½ per cent by the Post Office for "collection charge"—has been incorporated in the licence.

Geneva Conference

AFTER a session lasting three and a half months the extraordinary administrative radio conference, which, sponsored by the International Telecommunication Union, opened in Geneva on August 16th, has adopted a plan for the reallocation of frequencies between 4 and 27.5 Mc/s to such services as broadcasting, aviation and shipping.

Although at the time of going to press specific details of the plan and the agreement—approved by 52 of the 70 participating nations—are not available, it is known that the provisions regarding short-wave broadcasting are not to be introduced until after the 1955 international conference.

We hope to be able to review the findings of the conference in our next issue.

Television Progress

IN response to recent questions in the House of Commons regarding the progress in completing the remaining two high-power television stations, it was stated by the Asst. P.M.G. (Mr. David Gammans) that work on the £330 000 Wenvoe station is proceeding according to plan but it is uncertain whether the transmitter will be operating by the middle of 1952 as anticipated. The cable linking the station with London, which is being laid by the G.P.O., will not be ready for service before November, but a temporary radio link will, it is hoped, be available by the middle of the year.

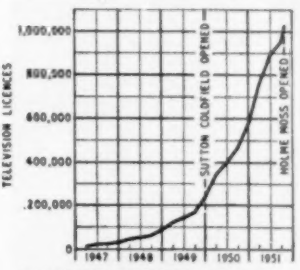
The Asst. P.M.G. stated that the cost of the radio link between Manchester and Kirk O' Shotts (the Scottish station) will be about £520,000. One of the relay towers for the radio link to Scotland will be on Pontop Pike, nr. Newcastle-upon-Tyne, the site of the proposed North-East low-power transmitter. It has, therefore, been suggested that this 5-kW station, costing some £200,000, should be the first of the five projected low-power stations to be built, but no such undertaking would be given by the P.M.G.

By the time this note is published test transmissions, using the 5-kW standby transmitter, at Kirk O' Shotts, will have been started. It is hoped by the B.B.C. to begin tests with pictures received over the radio link from Manchester in February. The nine relay stations will operate on frequencies around 4,000 Mc/s. No date has so far been given for the Scottish station to be brought into service.

Millionth Television Licence

DURING October the millionth television receiving licence was issued by the Post Office. By the end of the month, during which the number of licences increased by 73,450 (a record), the total was 1,031,950. It was recently stated by the Asst.-P.M.G. that it was estimated that there were some 100,000 unlicensed television sets in use. In an endeavour to stir the consciences of delinquents, the Post Office has issued a poster stating "don't be a pirate."

The number of "sound" licences in force in the U.K. at the end of October was 11,417,000, bringing the total number of licences to 12,448,950.



QUARTERLY GROWTH in the number of television licences in the U.K. since March, 1947, prior to which date viewers where permitted to operate receivers with "sound" licences.

Extra-Terrestrial Noise

SO far there has not been any international agreement on the frequencies to be used for the study of extra-terrestrial radio noise, which, of course, means that it is extremely difficult to correlate the measurements made in various countries. It has therefore been recommended by the International Scientific Radio Union (U.R.S.I.) that the International Frequency Registration Board be asked to assign on a world-wide basis seven frequencies with specified guard bands for "the international study of solar radiation and galactic radio noise."

The recommended frequencies are: 40, 80, 200, 320, 640, 1,280, and 3,000 Mc/s; and the respective guard bands ± 20, 25, 140, 500, 1,000, 3,000 and 3,000 kc/s.

It is pointed out by the U.R.S.I. that the Netherlands telecommunications authority has already made an effort to reach an agreement with adjacent countries on the use of frequencies for the study of solar radiation.

Radio Astronomy

RECEPTION of noise-like signals with strengths far below receiver noise level was recently demonstrated at the Royal Institution by Dr. J. H. Ratcliffe, of the Cavendish Laboratory. He used a faint electric bulb to represent a distant radio star, with a photo-cell and amplifier for the aerial and receiver. Heard over a loudspeaker the noise signal from the light source was normally indistinguishable from the amplifier noise, but by rotating a "chopper" disc in front of the photo-cell an audible note was produced proportional to the signal strength. In practice an interferometric aerial system is used (see *W.W.*, July, 1951, p. 276) and the chopping is done by switching in and out a quarter-wave line with a motor-driven capacitance switch, so altering the phasing of the two spaced aerials in a periodic fashion.

Television Convention

DURING the technical sessions of the Television Convention being organized by the Institution of Electrical Engineers (April 28th-May 3rd), which will cover all aspects of television from the programme production to the viewer, there will be demonstrations of equipment, includ-

ing large-screen projection television and, it is hoped, an early Baird 30-line receiver. Whilst the Convention will be open to anyone, the visits of inspection, which will include B.B.C. television studios and transmitters, the Post Office Research Station, the terminal equipment of the London-Birmingham co-axial cable link, and some commercial organizations, will be open to registered members of the Institution only.

The sessions into which the Convention is being divided are:

Opening Ceremony, followed by an introductory survey by Sir Noel Ashbridge; Historical—a paper showing the evolution of television from the end of the nineteenth century to the opening of the regular B.B.C. service in November, 1936; Programme Origination—covering cameras, camera channels, studio lighting and film scanners; Point-to-Point Transmission—cable and radio links, television-transmission measuring equipment; Broadcasting Stations—vision transmitters and techniques, aerials and feeders; Propagation—ionospheric influences in television reception, selection of transmitter sites; Receiving Equipment—Part I, receiver circuit techniques, Part II, cathode-ray tubes and valves; Non-Broadcasting Applications—large-screen television design problems, medical applications, film-aids and television wire broadcasting; and System Aspects—fundamental aspects of colour television, subjective aspects of viewing, contrast etc.

Copies of the programme and combined registration and order form for the Convention on "The British Contribution To Television" will be available soon from the Secretary of the Institution, Savoy Place, London, W.C.2.

Servicing Certificates

THE results of the 1951 Television Servicing Certificate Examination, held under the auspices of the Radio Trades Examination Board, have now been announced. Of the 53 candidates, 19 satisfied the examiners in all papers, 16 were referred in the practical examination and six who were referred in the 1950 practical examination qualified for the certificate. Twenty-nine candidates living outside the service areas of existing television stations sat for the written papers; 21 passed.

Closing dates for entries for the 1952 television and radio servicing examinations are January 15th and February 1st, respectively. Regulations and entry forms are obtainable from the Secretary, R.T.E.B., 9, Bedford Square, London, W.C.1.

Industry, Please Note

TWO pleas to the radio industry were made in speeches at the opening of the Radio Society of Great Britain's annual exhibition. C. I. Orr-Ewing, M.P., suggested that sub-standard television camera tubes might be made available to amateur television transmitters at low prices or on loan. F. Charman, president-elect of the R.S.G.B., urged makers of television receivers to design them to be as far as possible immune from interference from transmitters in the amateur bands—presumably mainly by choice of appropriate values of intermediate frequency.

Colour Television

THE October, 1951, issue of the *Proceedings of the I.R.E.* (America) is devoted almost entirely to contributions on colour television. Among the twenty articles one deals with the F.C.C. standards for colour transmission, and another, by Donald Fink (Editor-in-chief, *Electronics*), compares the relative merits and demerits of the frame-sequential and the colour sub-carrier systems.

A recent announcement from the U.S. Office of Defence Mobilization requests manufacturers to drop plans for the mass production of colour television receivers. It was, at first, intimated that it would "suspend all further development of colour television in order to free highly skilled electronics engineers for important military projects," but it has since been announced that research will not be interrupted.

"*W.W.*" *Index*

THE index to the 1951 volume of *Wireless World* is now ready and is available from our Publisher, price 1s (postage 2d). Cloth binding cases for the volume are also obtainable, with index, price 6s 5d by post. The binding of readers' own issues can be undertaken by our Publisher; the cost, including binding case and index, being 17s 6d, plus 10d for the postage on the bound volume.

PERSONALITIES

M. G. Scroggie, B.Sc. (Elec. Eng.) Edin., M.I.E.E., who describes a novel type of valve voltmeter in this issue, has been a contributor to *Wireless World* since 1923, and to *Wireless Engineer* since 1924. He was chief engineer of Burndept Wireless, Ltd., from 1928-1931, and since then, except for the war years, has been a consulting radio engineer. He was in charge of the early CH radar station at Pevensey and then at No. 9 R.A.F. radio school (radar) before going to the Air Ministry. Mr. Scroggie is the author of "Television" (Blackie) and of the *Wireless World* books "Radio Laboratory Handbook" and "Foundations of Wireless," the 5th edition of which has just appeared.

T. W. Bennington, writer of the article on "Propagation of V.H.F. *via* Sporadic E" in this issue, has had a long radio career, starting from 1926. He joined the B.B.C. in 1934, and since 1939 has been in charge of the ionospheric and short-wave propagation work of the Overseas Engineering Department. He has been a frequent contributor to *Wireless World* since 1932, and is author of the book "Short-wave Radio and the Ionosphere."

James Cleland has been appointed Engineer-in-Charge of the Scottish television station which is being erected at Kirk o' Shotts, between Glasgow and Edinburgh. He was at Alexandra Palace from 1936 to 1938, when he returned to the Scottish Regional station at Westerglen where he had previously been for four years. For the past few months he has been Acting Engineer-in-Charge at Westerglen. Mr. Cleland's assistant at Kirk o' Shotts will be W. L. Nicoll, one of the senior engineers at the Skelton short-wave station.

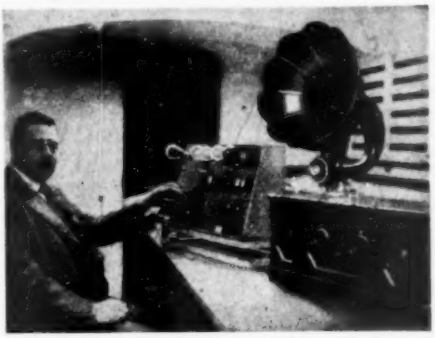
OBITUARY

It is with regret that we record the death of **Leslie McMichael,** chairman of McMichael Radio, Ltd., on November 17th at the age of 67. His associations with both the radio industry and the amateur radio fraternity extend over very many years. He was among the founder members of the National Association of Radio Manufacturers and Traders (subsequently R.M.A. and now B.R.E.M.A.) and, in 1913, of the London Wireless Club which became the Wireless Society of London—fore-

C. I. ORR-EWING, O.B.E., M.P., speaking at the opening of the R.S.G.B. show. Also in the picture are (left to right) H. Freeman, exhibition manager; L. Cooper, hon. sec.; W. Scarr, president; and J. Clarricoats, gen. sec.

runner of the R.S.G.B. He was for two years president of the Brit. I.R.E. (1944-46) and for his services to the amateur cause was elected an honorary member of the R.S.G.B. His appreciation of the part played by the amateur in the progress of radio was expressed in these words when addressing the Brit. I.R.E.: "As professional engineers, we should pay our tribute to the serious experimental work carried out without profit or reward by the radio amateur, who was among the first to appreciate and help forward the dissemination of radio knowledge."

We learn with regret of the death in Sydney, N.S.W., a few months ago of **Dr. A. L. Green,** who was officer-in-charge of the Ionospheric Prediction Service of the Commonwealth Observatory, Canberra. He was 46. Prior to joining the staff of the Radio Research Board in Sydney in 1930, he was for three years assistant to Sir Edward Appleton. He was with Amalgamated Wireless (Australasia) from 1935 until he joined the Observatory staff in 1947.



THE LATE Leslie McMichael photographed during test transmissions from a train in 1924.

IN BRIEF

Transatlantic Valve Liaison.—In response to an invitation from the Radio-Television Manufacturers' Association of America, the British Radio Valve Manufacturers' Association sent a representative to the first general conference of the Joint Electron Tube Engineering Council held in New Jersey at the end of November. P. A. Fleming, technical assistant to the B.V.A. secretary, represented the Association.

Technical Manpower.—The Technical Personnel Committee, reconstituted by the Government under the chairmanship of Lord Hankey, has set up a sub-committee to examine the problem of the manpower needs of the defence programme for radar, radio and electronics. Both the Radio Industry Council and the I.E.E. are represented on the committee.

Apprenticeship Scheme.—At the annual general meeting of the Radio and Television Retailers' Association it was announced that the Association, in conjunction with the Guild of Radio Service Engineers, was preparing a national apprenticeship scheme for the radio service trade. Full details of the scheme, which has yet to be approved by the Ministry of Labour, will be announced later.

India Television Project.—It is learned from our Bombay contemporary *Radio Times of India* that the Scientific Advisory Committee, recently appointed by the Government to advise the Ministry of Information and Broadcasting on the development of broadcasting, has recommended that a pilot television station be set up in India in order to study the art.

A.P.A.E.—The annual exhibition organized by the Association of Public Address Engineers will again be held at the Horse Shoe Hotel, Tottenham Court Road, London, W.C.2, on May 29th from 10 a.m. to 8 p.m. It will include this year a series of demonstrations. Further particulars are obtainable from the secretary, A. J. Walker, 394, Northolt Road, South Harrow, Middx.

R.T.E.B.—The Radio Trades Examination Board announces that S. A. Hurren, who recently retired from the Northern Polytechnic, has retired from the position of chairman of the R.T.E.B., which he has held since its formation in 1946. He is succeeded by E. J. Emery, who is managing director of E.M.I. Sales and Service. H. A. Curtis, director and secretary of the Radio and Television Retailers' Association, is deputy chairman.

Indian Exhibition.—A liaison committee was recently set up to act as the U.K. centre of information regarding the International Radio & Electronics Exhibition to be held in Bombay next November instead of February as planned. Wren Cowley, of Leland Instruments, is chairman of the committee, and B. A. Pettit, of Racal, Ltd., secretary. Enquiries regarding the exhibition, which has been postponed because of the failure of the monsoon, resulting in drastic cuts in supplies of water and electricity, should be addressed to the secretary at 41, Kingsway, London, W.C.2.

B.B.C. Reception.—The sixth of the twelve low-power stations to be brought into use by the B.B.C. to improve reception of the Home Service in certain areas was opened at Scarborough on November 11th. It radiates on 1,151kc/s. By the end of the year it is anticipated that the seventh station —a mobile transmitter—will be opened at Eastbourne.

Radar Prizes.—Bronze medals have been awarded by the Institute of Navigation for two radar papers read at meetings of the Institute. The recipients are: R. F. Hansford, of Sperry's, for his paper "Development of Shipborne Navigational Radar," and Capt. F. J Wylie, R.N. (ret.), Director of the Marine Radio Advisory Service, for "Radar and the Rule of the Road at Sea."

Correction.—In the list of components to "Radio Feeder Unit" (December issue, page 482), the type number of V. should be EB91.

For Teenagers.—The sixth Christmas lecture for older schoolchildren organized by the Institution of Electrical Engineers will be given at 3.0 on January 3rd and 4th. The subject is "Electricity in Civil Aviation," in which Capt. Peter Bressey, senior pilot of British European Airways, will review the contributions of electricity to safer and more reliable civil aviation—including radio, radar and other electronic navigational aids. Tickets are available from Savoy Place, London, W.C.2.

C.B.C. Finance.—Despite the fact that the revenue from sponsored programmes has increased fivefold compared with the pre-war figure, the Canadian Broadcasting Corporation incurred a loss of $1,271,874 in the year 1950-51. The Corporation's income was $8,301,379; nearly a third of which came from advertising. The Canadian license fee is $2.50. It is recommended that a statutory grant of $6,250,000 be made to the Corporation for each of the next five years. About 67 per cent of the past year's income came from licences and 30 per cent from sponsored programmes.

WHAT THEY SAY

G. Darnley-Smith, vice-chairman of the Radio Industry Council, speaking at the R.I.C. annual dinner on the f.m.-a.m. broadcasting controversy: "The a.m. bird gets the worm."

Sir James Barnes, K.C.B., K.B.E., a Permanent Under-Secretary of State for Air, addressing the Boy Entrants of Nos. 2 and 3 R.A.F. Radio Schools from Yatesbury and Compton Bassett, Wilts: "We are now spending on radio and radar as much money as we spent on all the aircraft we were buying shortly before the war. . . . Electronic equipment is in fact the eyes, the ears and the whole nervous system of the Royal Air Force."

INDUSTRIAL NEWS

Pamphonic Reproducers, Ltd., have developed commercially the system of delayed sound reinforcement described by P. H. Parkin and W. E. Scholes in our February, 1951, issue. D.S.R., as it is called, uses controlled time delays on each loudspeaker in order to preserve realism and the sense of direction.

Canadian Market.—Exporters of radio sets and components to Canada are recommended by the Board of Trade to ascertain the patent position regarding equipment before exporting. Most of the patents likely to be infringed are held by Canadian Radio Patents, Ltd. (receiving equipment), and Thermionics, Ltd. (valves). This and other useful information is given in the "Market Digest on Radio Components (Canada)," issued under the reference CRE(IB)60680/51 by the Commercial Relations and Exports Department, Thames House North, Millbank, London, S.W.1.

Murphy Staff Changes.—A new executive post, that of Director of Engineering, has been created by Murphy to "bring into closer relationship all the radio engineering and production activities." The new director is K. S. Davies, who joined the firm in 1933. He was in charge of the

television design section prior to the war. Since the war he has been general manager of the Electronics Division. P. Mc.C. Potter becomes works manager, with R. S. Miller taking his place as production manager. Mr. Potter joined the company in 1931 and Mr. Miller in 1937. Dr. G. David Reynolds, who joined the firm in 1933 and whose main interest has been set testing, is to be Chief Inspector of Television and Domestic Radio.

F. C. Robinson and Partners, Ltd., who specialize in the design and application of electronic control gear, have transferred their departments concerned with development, manufacture and servicing to new premises in Councillor Lane, Cheadle, Cheshire. Correspondence should continue to be sent to 287, Deansgate, Manchester.

Rees Mace Marine, Ltd., the radio marine subsidiary of Pye, Ltd., are now installed in their new factory at Oulton Broad, Lowestoft. The company's sales manager, R. I. T. Falkner, who was a naval communications specialist during the war, has been appointed to the Board.

Manufacturers' Register. — The 1951-52 "F.B.I. Register of British Manufacturers" (the 24th edition), which is published for the Federation of British Industries by Kelly's Directories and Iliffe and Sons, includes a Buyers' Guide listing over 6,000 F.B.I. firms classified under some 5,000 "products and services"; and directories of trade associations, trade names and trade marks. The information in this 882-page directory, which costs two guineas, is classified in English, French and Spanish.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"Two Electronic Resistance or Conductance Meters" by L. B. Turner, M.A., Sc.D., and "A Bridge for the Measurement of the Dielectric Constants of Gases" by W. F. Lovering, M.Sc., and L. Wiltshire, M.Sc., on January 8th. (Joint Meeting with Measurements Section).

"Comparison of Ionospheric Radio Transmission Forecasts with Practical Results" by A. F. Wilkins, O.B.E., M.Sc., and C.M. Minnis, M.Sc., on January 16th.

Discussion on "Should further Television Development be Concentrated on Colour to the Exclusion of Black and White?"; opener, L. C. Jesty, on January 28th.

Education Circle.—Discussion on "Essentials of a First Course in Electricity and Magnetism"; opener, H. Kayser, B.Sc., at 6.0 on January 23rd.

The above meetings will be held at 5.30 (except where otherwise stated) at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Group. — "The Sutton Coldfield Television Broadcasting Station" by P. A. T. Bevan, B.Sc., and H. Page, M.Sc., at 8.15 on January 15th at the Cavendish Laboratory, Cambridge.

North Eastern Radio & Measurements Group.—"The Automatic Monitoring of Broadcast Programmes" by H. B. Rantzen, B.Sc. (Eng.), F. A. Peachey, and C. Gunn-Russell, M.A., at 6.15 on January 7th at King's College, Newcastle-upon-Tyne.

North Midland Centre.—"Crystal Diodes" by R. W. Douglas, B.Sc., and E. G. James, Ph.D., and "Crystal Triodes" by T. R. Scott, B.Sc., at 6.30 on January 8th at the Hotel Metropole, Leeds.

Discussion on "Is the Scope of Electrical Engineering Courses too Narrow?"; opener, R. A. H. Sutcliffe, B.Sc. (Eng.), at 6.0 on January 29th at the Lighting Service Bureau, 24, Aire Street, Leeds.

North-East Scotland Sub-Centre.—Informal Lecture on "The Operation and Maintenance of Television Outside-Broadcast Equipment" by T. H. Bridgewater at 7.30 on January 9th at the Caledonian Hotel, Union Terrace, Aberdeen, and at 7.0 on January 10th at the Royal Hotel, Union Street, Dundee.

South Midland Radio Group.—"Crystal Diodes" by R. W. Douglas, B.Sc., and E. G. James, Ph.D., and "Crystal Triodes" by T. R. Scott, B.Sc., at 6.0 on January 28th at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Rugby Sub-Centre.—"The Use of Saturable Reactors as Discharge Devices for Pulse Generators" by W. S. Melville, B.Sc.(Eng.), at 6.30 on January 16th at the Rugby College of Technology & Arts, Rugby.

Western Centre.—Faraday Lecture on "Sound Recording—Home, Professional, Industrial, and Scientific Applications" by G. F. Dutton, Ph.D., B.Sc.(Eng.), at 6.45 on January 10th at the Sophia Gardens Pavilion, Cardiff.

British Institution of Radio Engineers

London Section.—"Crystal Triodes" by E. G. James, Ph.D., and G.M. Wells, B.A. (G.E.C. Research Laboratories) at 6.30 on January 9th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section. — "Television Aerials" by G. L. Stephens (Belling & Lee) at 7.0 on January 17th at the Natural Philosophy Department, The University, Drummond Street, Edinburgh.

North Eastern Section.—"Test Gear Design" by A. W. Wray, M.A., at 6.0 on January 9th at Neville Hall, Westgate Road, Newcastle-upon-Tyne.

South Midlands Section.—"Propagation and Reception of Television Signals" by G. L. Stephens (Belling & Lee) at 7.15 on January 15th at the Public Library, Rugby.

British Sound Recording Association

London Section. — Discussion on "Gramophone Motors"; opener, E. Mortimer, at 7.0 on January 18th at the Royal Society of Arts, 6, John Adam Street, London, W.C.2.

Portsmouth Centre.—"The Processing and Pressing of Disc Recordings" by E. B. Pinniger at 7.30 on January 9th at the Central Library, Guildhall Square, Portsmouth.

Television Society

"The Planning and Development of Television Broadcasting Stations" by P. A. T. Bevan, B.Sc., M.I.E.E. (B.B.C.), at 7.0 on January 25th at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

Leicester Centre.—"Valves for Television Receivers" by K. S. Phillips (Edison Swan) at 7.0 on January 7th at the Leicester College of Technology, Room 45, The Newarkes, Leicester.

Institution of Electronics

Southern Branch.—"The Synchrodyne" by D. G. Tucker, D.Sc., A.M.I.E.E. (Royal Naval Scientific Service), at 6.30 on January 16th at Southampton University College.

Institute of Practical Radio Engineers

North Eastern Section.—"Test Instruments," by C. A. Pratt (Avo), at 7.30 on January 17th at the Roma Café, Hindmarsh Square, Heber Street, Newcastle-upon-Tyne, 1.

NEWS FROM THE CLUBS

Edinburgh.—A wide range of subjects is included in the current programme of the Lothians Radio Society, which meets on alternate Thursdays at 7.30 at 25, Charlotte Square. The January meetings will be held on the 17th and 31st. Sec.: J. Mackenzie, 41, Easter Drylaw Drive, Edinburgh, 4.

Exeter.—January meetings of the Exeter Radio & Television Club include a talk and demonstration on the detector (10th), a competition for home-constructed gear (17th) and a talk on the uses of vectors and the "j" operator in practical radio (31st). Meetings are held at 7.30 at the Exeter Hobbies Association Hut, Haldon Road. Sec.: L. R. Jenkin, 16, South Avenue, Exeter.

Manchester.—A demonstration of home-constructed television equipment will be given to members of the South Manchester Radio Club at their meeting on January 4th. Meetings are held on alternate Fridays at 7.30 at the Tatton Arms, Northenden. Sec.: F. H. Hudson, 21, Ashbourne Road, Stretford, Manchester.

Worthing.—Meetings of the Worthing & District Amateur Radio Club are held on the second Monday of each month at the Adult Education Centre, Union Place. The Mullard film-strip on valves will be shown at 7.30 on January 14th. Sec.: F. H. Betterley, 42, Anweir Avenue, Lancing, Sussex.

Radio Control.—January meetings of three of the groups of the International Radio Controlled Models Society have been received from the secretary, C. H. Lindsey, VI, 3rd Court, Christ's College, Cambridge. The Birmingham Group will meet at 2.30 on January 5th at the International Centre, 83, Suffolk Street, Birmingham, when there will be a talk on the development of a 27-Mc/s crystal-controlled transmitter. The London Group meets at 2.0 on January 13th at the Horseshoe Hotel, Tottenham Court Road, W.C.1. At the meeting of the Tyneside Group at 7.0 on January 26th at 176, Westgate Road, Newcastle-upon-Tyne, members will discuss transmitter and receiver circuits.

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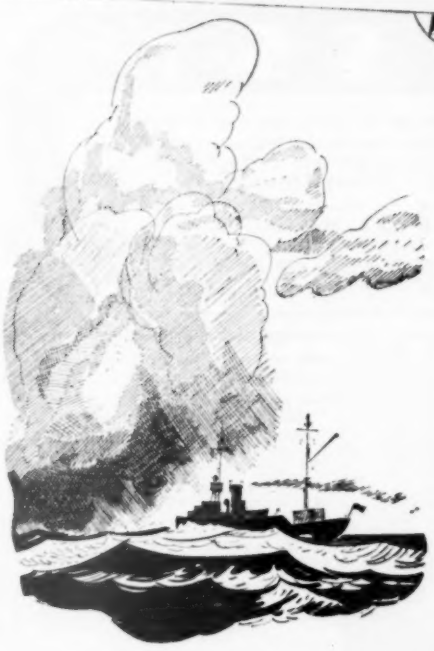

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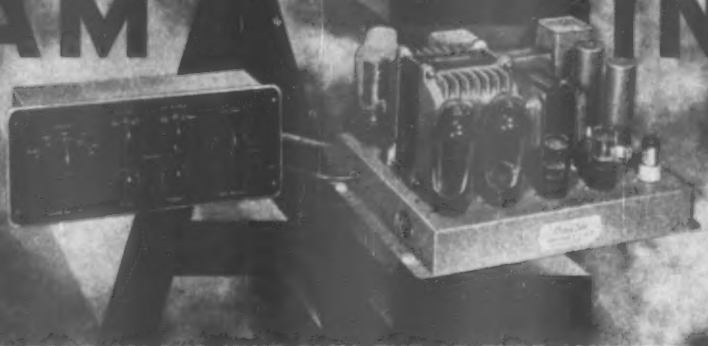

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I.41

SERVO-MECHANISMS

A Simple Approach from First Principles

By P. L. TAYLOR,* M.A.

MANY people are aware that there is a large and growing class of automatic controlling and regulating devices, developed over the past few decades, which promises to revolutionize our ideas of how accurately machines and processes can be controlled. Such devices perform diverse functions —for example, the automatic piloting of an aircraft, gunlaying aboard ship, the milling to shape of hard metal from a wooden master pattern, or keeping a telescope trained on a star. Nevertheless, there is such a strong family resemblance in the mode of operation that they are all called servo-mechanisms, or "servos" for short. Unfortunately, anyone who would like to know more about how they work and what their characteristics are is rather poorly served by the available literature, which tends to be very mathematical. This is a pity because, although complicated systems naturally demand complicated mathematical treatment, the fundamental principles involved are in reality quite simple. Indeed, many of them are already familiar to the radio engineer.

To answer the question, "What is a servo-mechanism?" it is perhaps best to consider first why servos have been developed at all. Since the discovery of the power of steam, and its harnessing in the industrial revolution, man has been enabled by building and controlling machines to perform tasks previously beyond his powers and at the same time to reduce the effort required of him. But it has become increasingly apparent that sometimes he is an imperfect controller of the machines he has created, which inherently are capable of better results than he can produce with them. Hence the replacement of the human operator by an automatic controller, resulting in the servo-mechanism.

This replacement is possible because the task of the controller (human or mechanical) is essentially simple (Fig. 1). The operator has in his mind's eye a picture of the result he desires to achieve, and at the same time can see what is actually happening. His sole function is to compare the two impressions, and so to operate the machine as to reduce the difference between them. He is thus primarily an error-determining device; and the amount of error determines how he causes the machine to release energy from the external source to produce the desired result.

Compare this with a typical simple position-control servo (Fig. 2). Here a load with some inertia (for example, a gun mounting) has to be rotated so that its angle θ_o corresponds to the angle θ_i of a controlling shaft. The load is driven by a motor, whose torque is controlled in turn by an amplifier. The positions of the input and output shafts are compared, and an error signal ϵ proportional to the difference between them supplies the controlling input to the amplifier. The sense of rotation of the motor is so arranged that it will tend to reduce any error, i.e., to drive the output shaft into alignment with the input shaft.

Thus Figs. 1 and 2 are essentially the same except that the human operator has been replaced by a mechanical or electrical error-measuring device. The similarity is complete if we consider the amplifier/motor system to be simply a machine which produces a torque T on the output shaft equal to K times the error. The higher the gain of the amplifier, the larger is the constant K.

This simple system has all the characteristic parts of a servo-mechanism—an error-determining device comparing the input and output quantities, and controlling through some machine the flow of energy from an external source to a load. In particular, little or no torque is required to turn the input shaft. This is a great advantage where this shaft is turned by some other mechanism—e.g., a predictor—which is capable of only a small power output. It will be seen from Fig. 2 that there is a closed loop or sequence of dependence of the various quantities on each other. This gives rise to the alternative name for a servo-mechanism—that of a "closed-loop control mechanism."

How will such a system behave? This depends not only on the constants of the system, but also on the

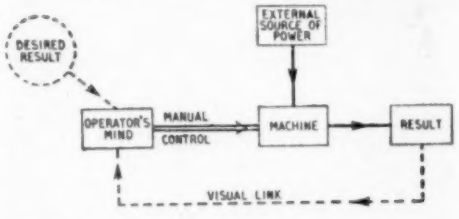


Fig. 1. Functions of a human controller.

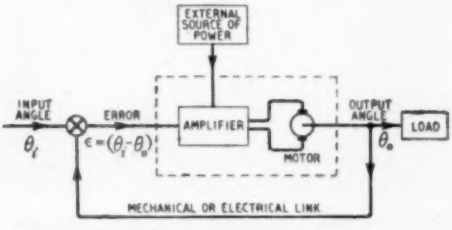


Fig. 2. Simple position-control servo.

*College of Aeronautics, Cranfield.

way in which θ_i varies with time. Thus in servo work it is common to find various types of input variation considered; the choice of the most suitable for a particular purpose depending on the job the servo is to perform. For example, if the load of Fig. 2 is a gun which is to fire at fixed targets, i.e., its bearing is to be changed from one fixed angle to another, then performance may be analysed in terms of the step-function input of Fig. 3 (a). It is assumed that initially the system is at rest, with $\theta_o = \theta_i$, and at a θ_i suddenly changes to a new value. θ_o cannot follow immediately due to the inertia of the load. The error therefore increases from zero to θ_i and a large torque is applied to the load. As the load accelerates and θ_o increases, so the error and torque are reduced until at b θ_o reaches the required value and they become zero. But by this time the load has acquired considerable kinetic energy and consequently overshoots. The error increases in the opposite sense and a reverse torque is applied which eventually brings the load to rest at c, and then accelerates it back again until once more it passes through the required position at d. But again it has acquired kinetic energy in the period c-d and another overshoot occurs. In the simple system considered this oscillatory behaviour continues indefinitely and the system is therefore unstable and useless. It is said to "hunt."

To find a cure, it is necessary to seek the cause of the instability. This has been hinted at above; it is the time-delay between the application of the signal and the arrival of the load at the required position. During this time there is an error signal due to the closed-loop arrangement, with consequent release

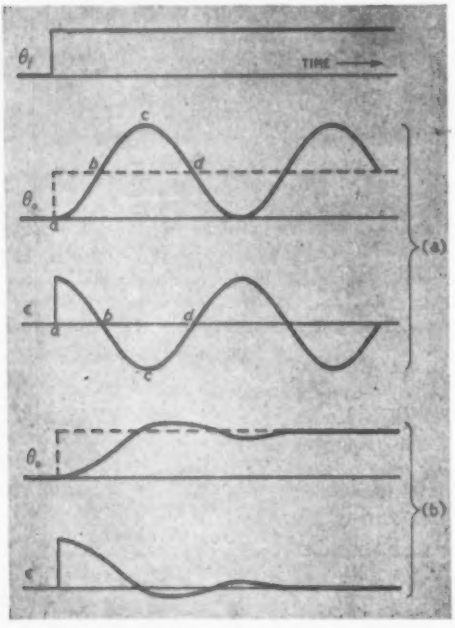
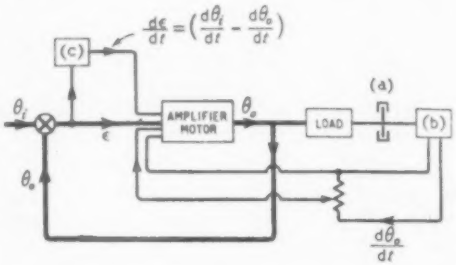


Fig. 3. Response of simple servo of Fig. 2 to a step input (a) without damping (b) with nearly critical damping.

Fig. 4. Alternative methods of stabilization. (a) damping on output shaft, (b) velocity feedback, (c) error-rate feedback.



of energy from the source into the load, and it is this energy which causes the load to overshoot. To stabilize the system, therefore, the energy released must somehow be absorbed—for example, in an eddy-current brake on the output shaft, (a) in Fig. 4, or in the general case by some damping device which will produce a retarding torque proportional to the speed of rotation.

It is worth noting here the inherent tendency to instability exhibited by servo-mechanisms, due to (a) the inevitable time-delay in a practical system in the transmission of signals round the closed loop, and (b) the consequent release of surplus energy into the system. From this follows the fact that a large part of servo work is devoted to minimizing time-delay and hence the surplus energy, or to dissipating it harmlessly once released.

With a suitable amount of damping a response such as that of Fig. 3(b) can be obtained, which would be quite suitable for the application just described. To increase the speed of response, the factor K can be increased, but it is important to note that this will also mean increasing the damping if the same degree of stability is to be maintained. Another factor influencing the choice of K is the effect of an external torque applied to the load; for example, wind loading on the gun turret of a bomber. Such a torque will tend to deflect the load and will ultimately be balanced by an error-torque from the servo. The higher K is made the less will be the error required to produce the balancing torque, i.e., the harder it will be to deflect the load against the restraining action of the servo. K is therefore sometimes known as the "stiffness" of the system.

Velocity Feedback

The above method of damping is wasteful in that any energy drawn from the source is ultimately dissipated as heat in the damping device, which would be a serious matter in a large servo. The question can naturally be asked, is it possible to stabilize the system by some other method which is not wasteful of energy?

A clue to an answer can be found in studying the behaviour of a human controller faced with the same task of rotating a load from one bearing angle to another. On receipt of his instructions (corresponding to the step input of Fig. 3) he will cause the driving motor to apply a torque accelerating the load. The motor will draw the necessary energy from the supply. As the load gathers speed and approaches the required

position, the operator anticipates that it will overshoot, and therefore reverses the motor torque. Under this condition the load will be driving the motor—i.e. passing back to it the energy acquired earlier. The motor will therefore be acting as a generator, and the excess energy is returned to the supply instead of being dissipated. If the operator is skilful the result is that the load comes to rest just as it reaches the required position. This is shown in Fig. 5(a).

In the case of the servo this behaviour is imitated by attaching a tachometer generator to the output shaft, (b) in Fig. 4. A voltage is produced proportional to the velocity of this shaft and a suitable fraction of this voltage is fed back to the input of the amplifier in opposition to the error signal—a process known as velocity feedback. The action is shown in Fig. 5(b). Initially the error signal predominates and the load is accelerated. As the load velocity rises and the error falls, the net input to the amplifier drops rapidly and then increases in the opposite sense, so that a decelerating torque is applied to the load before it reaches the required position. In addition to the advantage over a physical damping system of not causing a waste of energy, the velocity feedback method possesses the important practical advantage that the amount of voltage fed back, and hence the damping, can be simply controlled by setting a potentiometer.

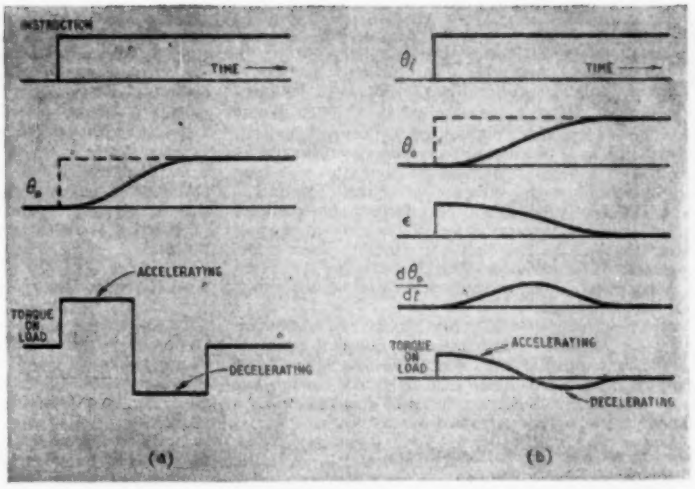


Fig. 5. (a) control by human operator, (b) action of velocity feedback.

Error-Rate Feedback

So far so good. But suppose the servo is required to perform a somewhat more difficult task? For example, suppose the gun is an anti-aircraft gun, which is required to follow a moving target? Behaviour in this case might be investigated in terms of the type of input shown in Fig. 6. This corresponds to the input shaft suddenly being rotated with a constant velocity, i.e. θ_i increasing linearly with time. For a servo with velocity feedback the ultimate result, after any initial transients have had time to die out, is that the output shaft will rotate at the same speed as the input shaft but will lag behind it by some (constant) angle, an effect known as "velocity error." (The term is perhaps a bit misleading as the error is not one of actual velocity—both input and output shafts rotate at the same speed—but is an error of position due to the fact that the shafts are moving.)

It arises in the following way. Since the output shaft is rotating, the tacho-generator will produce a voltage input to the amplifier. On the other hand, since the load is neither being accelerated not decelerated, no torque is required from the motor, i.e. the net input to the amplifier must be zero. This can only be so if there is an error signal (and consequently an error) to compensate for the velocity feedback signal. It follows that the error will be proportional to the speed of the output (and input) shaft.

However, if some other signal proportional to speed can be used to offset the velocity feedback, then the error can be made zero. This might be done by attaching a second tacho-generator to the input shaft and feeding its output into the amplifier. There

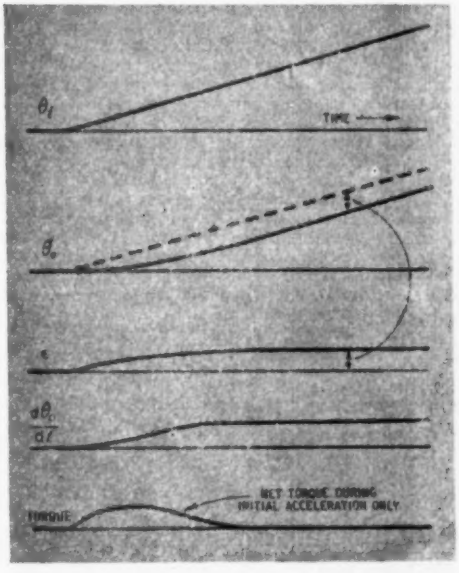


Fig. 6. Showing velocity error in a velocity-feedback stabilized servo.

would then be three signals fed into the amplifier: (a) the error, (b) the velocity feedback signal proportional to $d\theta_o/dt$, and (c) a signal in opposition to this proportional to $d\theta_i/dt$.

In practice a simplification is possible. Since $\epsilon = \theta_i - \theta_o$, then $d\epsilon/dt = d\theta_i/dt - d\theta_o/dt$, so that it is possible to produce both of the signals proportional to velocity, in opposition to each other, by differentiating the error signal. Both tacho-generators can thus be dispensed with, giving "error-rate feedback." This differentiation might be effected, for example, by applying the voltage output of the error-measuring device to a series CR circuit of suitably short time-constant. The voltage appearing across the resistance is then proportional to the differential of the input (i.e. error) voltage.

It is possible to continue this process of considering more complicated performance requirements in terms of different input signals, and discussing methods of eliminating any errors that may arise, but enough has been written to show the general picture, and to explain some of the terms in common use.

Servos as Feedback Amplifiers

The reader will have noticed the strong resemblance between Fig. 2 and the usual block diagram of an amplifier with negative feedback, having a feedback factor of unity. (The most obvious similarity is the possibility of instability. In the case of the feedback amplifier this is usually investigated in terms of a phase-shift round the loop of 180 degrees, but such a phase-shift is, of course, the same as a time-delay of half a cycle.) It follows that the methods that have been developed for feedback amplifier work can be transferred, almost lock, stock and barrel to the servo field. For example, analysis can be conducted in terms of the response to sinusoidal signals rather than to transients such as those mentioned above. This can simplify calculations by permitting the use of the j notation and obviating the necessity of having to solve complicated differential equations. This is possible because the equations of motion of mass, stiffness and damping resistance are the same, with a change of symbols, as those of inductance, the reciprocal of capacitance, and electrical resistance (see Table). One can therefore write down an "equivalent circuit" to represent an arrangement of masses, stiffnesses, etc., and analyse behaviour in terms of this circuit. There is also the practical advantage with sinusoidal signals when it comes to measuring the performance of an actual servo that the oscillations, being continuously repeated, can be studied at leisure, whereas with transient signals and a quick-acting servo it may be necessary to resort to recording first.

Stability can be studied in terms of the Nyquist diagram, and when necessary improved by inserting suitable phase-advancing networks in the loop. (This is the same thing, of course, as reducing the time delay round the loop). There is, however, the disadvantage that it is not easy to obtain the transient response of a system (where this is required, as it usually is with a servo) directly from the frequency response without laborious calculation in terms of Fourier synthesis. The television and radar engineer is familiar with this drawback: he often will design an amplifier in terms of its frequency response because that is the simplest method, whereas its performance in practice is better represented by its response to pulses.

TABLE

Electrical Quantity		Mechanical Quantity	
E.M.F.	E	Force	F
Current	I	Velocity	V
Charge	Q	Displacement	S
Capacitance C; $I = \frac{E}{C}$		Stiffness D; $D = \frac{F}{S}$	
Inductance L;		Mass M;	
$E = L\frac{dI}{dt} = L\frac{d^2Q}{dt^2}$		$F = M\frac{dV}{dt} = M\frac{d^2S}{dt^2}$	
Resistance R; $E = IR$		Resistance R; $F = VR$	

The Human Operator

It was stated above that the human operator has certain characteristics which may limit the performance of any system of which he forms a part. By studying these, two lines of thought are opened up. First, a guide can be obtained as to whether a human operator should be used or not for a particular system; and second, if a human operator must be used, his characteristics can be taken into account in designing the machines he controls so that the best overall result is obtained.

Much work has yet to be done in this field, and results so far obtained can only be expressed generally as there is considerable variation between one person and another. The principle characteristics appear to be these. First, there is an inherent time delay of about 0.2-0.3 second between a stimulus and the operator's response, known as reaction time. This is by no means constant for a particular person, but can vary with the amplitude and nature of the stimulus. Second, the amplitude of the response is not necessarily proportional to that of the stimulus—indeed, for certain type of small stimuli, there may be no response at all. Thirdly, there is the obvious characteristic of fatigue. As the operator tires his reaction-time increases, and in bad cases he may even do the wrong thing in response to a stimulus. Against these obvious drawbacks must be set the facts that an operator is capable of learning and adjusting himself to a particular situation. For a repetitive job, he can offset some of his inherent time delay by anticipation, corresponding to the use of velocity feedback as seen above. With practice he can produce progressively better results, corresponding to an adjustment of the amount of feedback.

It will thus be seen that, other considerations apart, the human operator is unsuitable where a very rapid response is required, or where there is likely to be excessive fatigue. Two examples will suffice to show what can be done by suitable design of the system where a human operator must be used. We have seen above that the possible stiffness of a system is limited by the time delay in the loop. It follows that there is an optimum value of stiffness corresponding to the reaction time of the operator (plus other time delays in the system), and an attempt to give him more precise control by increasing the stiffness will actually lead to instability and a worsening of the overall performance. The second example is that of a radio aid to the navigation of an aircraft, in which the pilot is given a left right indication on a meter as to how far he is from the required track. If he is to keep to the track accurately the indication must obviously be sensitive, and the performance requirement may be such that this sensitivity corresponds to too great a

system stiffness. If, somehow, velocity feedback could be introduced the pilot's performance could be much improved; for instance, by making the meter indication proportional not to error alone, but to a combination of error and the rate at which the track is being approached—a process known as "rate-aiding."

What of the future? Speculation is interesting, though actual prophecy may be dangerous. But following the line of thought suggested earlier, it would seem safe to say that as man designs machines to perform more and more complicated tasks, and at the same time tries to reduce his own physical and mental effort in controlling them, servo-mechanisms will become increasingly important.

Germanium

Recent Progress in its Application to Crystal Valves

By T. H. KINMAN, M.B.E., M.I.E.E.*

THE discovery, about 1948, that a germanium crystal rectifier could be converted into an amplifier, or made to generate oscillations like a thermionic valve, by the addition of a second cats-whisker aroused considerable interest and speculation.

The crystal triode was first demonstrated in America, operating radio sets, microphone amplifiers and other electronic equipment from a single dry battery consuming only a few milliamperes. Consequently there was general anticipation that this novel device would soon be made available for use in other electrical apparatus, for example, deaf aids, or for applications where the use of electric power to heat the valve filaments was a serious difficulty.

There were, however, many reasons why these original crystal triodes could not be made to replace the valve. Apart from the difficulty of uniform mass production, their electrical characteristics compared unfavourably with those of valves. In brief, there seemed to be no advantage in using them except for experimental purposes. It was appreciated by those with some knowledge of the subject that further development would be required before serious competition with the valve was possible.

It is interesting to recall that the use of microwaves in radar during the late war[1] stimulated work first in Britain and then in America on semi-conductors, or crystal detectors as they are more generally known, as a means of converting very high frequencies—difficult or impossible to amplify—into lower or intermediate frequencies by the superheterodyne principle, as used in radio and television sets.

Silicon was found to be the most suitable material for this purpose, but although a very efficient frequency converter it was easily damaged or destroyed if electrically overloaded. Consequently, a search was made for a more suitable material, having similar characteristics to silicon as a frequency converter but more electrically robust. Germanium seemed to be the most promising substance to work on. It was soon realized, however, that whilst germanium would withstand relatively heavy electrical overloads without impairment it would not compete with silicon, either as a converter or detector of very high radar frequencies. Fig. 1 illustrates the falling-off in efficiency with frequency of a germanium rectifier, compared with a silicon rectifier at that time. However, other applications were apparent.

Since the rectification efficiency of the germanium crystal was very good over a wider frequency range than other solid-state rectifiers and it was able to withstand higher applied voltages—of the order of 80 volts or more—there was an immediate demand for this rectifier to replace thermionic diodes in many radio and electrical circuits.

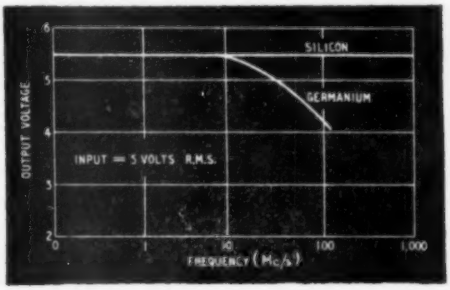
In this country The British Thomson-Houston Company started production in 1946, when the only available source of germanium was the United States—where commercial manufacture had started during the war by utilizing residues recovered from zinc and cadmium production. The total estimated yield from this source, however, was not more than 2,000 lb per annum, and its purity was not guaranteed with any certainty. Nevertheless, British and American manufacturers continued to expand their production of germanium rectifiers, although mass production methods could not then easily be applied.

Later, the work of American industrial scientists[2] on the germanium crystal triode led to a better appreciation in Britain of the importance of germanium as a means of producing many revolutionary electronic devices. It was also realized that latent stocks of this valuable material were present in British coal as a by-product.

The initiative taken by the General Electric Company in extracting germanium from the flue dust collected in the chimneys of our gas production plants all over the country and the development of an economic method of extraction by Johnson Matthey & Company has already been described.[3] Equally im-

* The British Thomson-Houston Company.

Fig. 1. Frequency response curves of typical silicon and germanium crystal rectifiers.



[1] References at end of article.

portant was the work of the manufacturer in extracting grosser impurities from the raw material, so that, for example, it could be guaranteed to contain less than 1 part per million of the contaminating arsenic.

The assurance of an abundant home supply of germanium, coupled with a defined standard of purity, encouraged British manufacturers to organize their production of germanium devices, especially diodes, on a much larger scale, approaching the mass-production technique common in the manufacture of valves. Fig. 2 shows the cross-section of a germanium crystal diode moulded in a thermo-setting plastic material.

In the meantime, industrial scientists in America had been working hard to eliminate the injurious impurities from the metallic germanium—using the progressive solidification technique, well-known to metallurgists. In this process impurities present in the crystal lattice are driven towards the molten end of an ingot as recrystallization takes place; the impure end of the ingot is then cut off. The process may be be repeated many times to obtain the highest possible purity, judged by the resistivity of the metal.

A much more important and revolutionary development has since been reported.[4] Instead of processing the surface of the germanium, where the normal rectification phenomenon is observed, rectifying barriers can now be produced *inside* the metal, thus dispensing with the somewhat haphazard surface contact with a catswhisker. With this internal barrier, or p-n junction as it is called, end wires can be soldered solidly on to the plated surface of the metal for connection to the electrical circuit, thus providing a much better mechanical job than is possible with a surface-contact diode or triode.

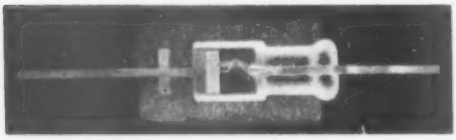
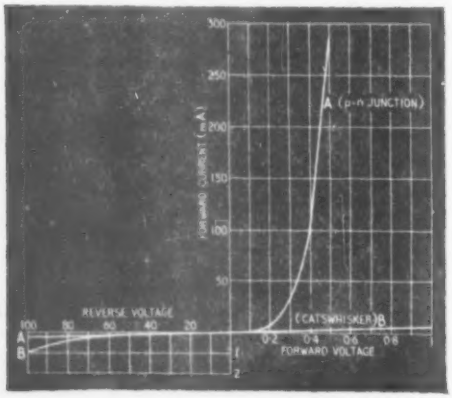


Fig. 2. Cross-section of a germanium crystal rectifier moulded in thermo-setting plastic.

Fig. 3. Static characteristics of (A) B.T-H. experimental p-n junction germanium diode and (B) typical commercial germanium diode with catswhisker. (Different scales are used for forward and reverse voltage and current).



The theory of rectification and transistor performance with p-n junctions has been described in many technical articles and publications,[5] but it many not be generally know that to make these new devices a new technique is required for the production of the germanium metal. It must be intrinsically pure and in the form of a single crystal, as distinct from the polycrystalline material used for the earlier types of diodes and triodes with catswhiskers. Thus, the purification and production of single-crystal material is in itself a most important advance in the art of crystal manufacture, and is likely to be adopted in all future production—whether for p-n junction devices or for the surface-contact rectifier or triode.

The p-n junction diode or p-n-p junction triode is found to be much more efficient than the surface-contact type. The power handling capacity of the catswhisker-type diode, for example, is seriously limited because of the small contact area, usually not more than about 0.0005 sq. in. On the other hand the p-n junction area may perhaps be as large as 0.1 sq. in, depending on the particular application, i.e., whether for low or high power service. It is also claimed that p-n barrier type diodes and triodes generate much less internal noise than surface-contact types, although the reason for this is not yet fully understood. Fig. 3 illustrates the improved d.c. static characteristic of an experimental p-n junction type germanium diode made in the B.T-H. Research Laboratory. For comparison, the d.c. characteristic of an average point-contact germanium crystal diode is also shown.

There seems no doubt that an important turning point has been reached in the understanding and better use of this hitherto rare element, germanium.

If the production of p-n junction devices can readily be translated from the laboratory to the factory, we may look forward to a new era in electronics: small and robust diodes and triodes to replace valves with great reduction in power consumption and better electrical efficiencies and longer lives. Some limitations, however, must be expected. For example, germanium, in common with all semi-conductors, is sensitive to temperature changes; its characteristic changes rapidly above some critical temperature—usually over 100 deg C. Nevertheless, the number of useful applications justifies an intense effort being made in this country to exploit to the full our natural resources of the material.

With the present limited demand, British germanium production is not much more than about 1,000 lb of metal per annum. The mass production of these new crystal valves, however, might easily require the stepping-up of our production several hundred times, not only for home consumption but for export—especially to America.

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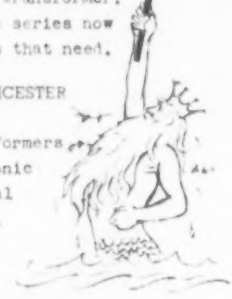

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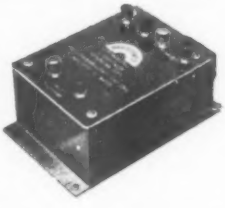

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ENERGY

—*Not Something Theoretical but the Real Stuff of Electricity*

says "CATHODE RAY"

MOST people, no doubt, think energy is the thing they haven't much of on Monday mornings. And certainly that idea fits quite well into the usual scientific textbook definition of energy as "capacity for doing work." But then "work" in this definition has a special and limited meaning, which may or may not include what we do for a living. Of course anybody who has had to study the science of engineering is familiar with the special meanings of "work" and "energy." But just now I have in mind the many *Wireless World* readers whose knowledge of electricity is practical rather than academic. They feel quite at home with volts and amps, but if they have thought at all about electrical energy they may look on it as something rather theoretical. If so, they will be surprised when I say that energy is the real stuff, and volts and amps are of secondary importance.

But surely, if there is anything about electricity that is on a strictly practical basis it is the amount charged on the bill. If we were to treat that as of merely theoretical interest, the local Electricity Board would soon disillusion us. We are charged for so many units at so much per unit. Units of what? Not of pressure. Volts are not priced at so much each. Nor of current. My account says current, but in that respect at least it is wrong. Otherwise a step-down transformer would raise the value of the electricity supply by stepping up the current. What about power—watts? True, "watts = volts × amps," which rules out the transformer effect; what is gained in amps is lost in volts. But a person who used 1,000 watts for a few minutes each day would not be charged ten times as much as one who used 100 watts day and night. Time must be taken into account. The units of electricity bills are in fact kilowatt-hours. That happens to be a convenient size for commercial transactions. But clearly it is not one of the set of units that includes the volt, the amp, and the watt. For one thing, the "kilo" introduces a thousand-fold multiplication. And then the hour is not the basic unit of time. Whether one embraces the new m.k.s. series of units, or sticks to the old c.g.s., there is no doubt about time being reckoned in seconds. So the practical or absolute unit of what one pays for—energy—is the volt-amp-sec or watt-sec and is called the joule, a name that may not even ever have been heard of by many whose trade is in volts and watts. Obviously one "unit" of commerce equals $1000 \times 60 \times 60 = 3.6$ million joules, so joules are very cheap (Ha-ha!).

Energy in Various Guises

I hope that by now I have convinced everybody who needed to be convinced that energy is the real stuff. Like food. The advertisements may have a lot to say about the flavour, colour, aroma, etc. of food, but these qualities alone would not sustain one for long. And the voltage at which electrical energy is delivered may be important, but not so important as the energy itself. As a matter of fact the analogy between food and electricity is closer than one might think. The energy value of food, as every newspaper reader knows nowadays, is measured in calories (strictly, kilocalories). It could easily be measured in joules, or even kilowatt-hours, because one kilocalorie equals 4,184 joules. So the 3,000 or so needed to keep a person going for a day is the equivalent of 3½ kilowatt-hours, purchasable in most areas for about fourpence. It would save a great deal of trouble and expense if instead of having to eat we could plug ourselves into the mains overnight, during the off-peak period. Perhaps, however, not; I have just reckoned that even if spread over eight hours it would create such a load that the resulting power cuts would cause mass starvation.

But although the human body is not constructed to receive its intake of energy in electrical form, an important thing about energy is that it does exist in various forms—electrical, thermal, magnetic, mechanical, chemical—and there is a fixed "rate of exchange" between them all, so that it is possible to measure all in the same units. For instance, the electrical energy received by a resistor is directly converted into heat energy, and each joule of electrical energy always creates the same amount of heat. So heat can be measured in joules too. And so can the energy of motion possessed by a flying bullet or the magnetic energy stored in a field core. This fixed rate of exchange means that the total energy of all kinds in the universe can neither be increased nor decreased; all that can be done is to vary the distribution among the different kinds. This observed fact is called the Law of Conservation of Energy.

Mass and Energy

Until recently there was what seemed to be an entirely separate Law of Conservation of Mass, which said that the amount of material stuff in the universe was also fixed. You couldn't reduce the amount by burning or any other process; you merely changed it into an equal amount of carbon dioxide and water vapour, or whatever it might be. It is now known that these two laws are really one; there is rate of exchange not only between different kinds of energy but also between energy and mass, these two being just different forms of the same thing.* An atomic explosion differs from ordinary kinds in that some of the explosive not only disappears from view but is completely annihilated, being directly converted into a large amount of energy. But this process is not yet one that can fittingly be employed in the homes of even *Wireless World* readers, so as far as we are concerned conservation of energy holds.

However, those who still find it rather difficult to

* The basic equation is $E = c^2m$, where E is energy, m is mass, and c is the velocity of light, all in c.g.s. units. So the energy value of one gram is no less than 90,000,000,000,000 joules, or 25,000,000 kilowatt-hours.

grasp the idea of energy as a definite commodity, worth so much money per unit, may find it useful to remember that it is so closely related to mass. Mass, by the way, is reckoned for most practical purposes as weight but of course it is more fundamental than that because the weight of a thing depends on where it is—in outer space it is almost nil—whereas its mass is constant.

One difficulty about energy is the way the word is commonly used. If we found a friend pushing a lawnmower at high speed we might remark "What energy!" But in the scientific sense of words it would be more accurate to say "What power!" For power is the rate at which energy is expanded. If our friend's effort were short-lived, his energy would in fact be smaller than that of a less spectacular worker who kept going until the job was finished.

Gas—Another Viewpoint

All this may seem to be getting far away from radio. But it is, as the French are supposed to say, *reculer pour mieux sauter*—stepping back to get a better jump. Most people find it difficult or even impossible to think about such things as electrical energy without some sort of analogy. And as mass is not only the basis on which most materials are sold, and at the same time is scientifically a disguised form of energy, it makes a suitable analogy. This is particularly so of such a thing as gas. Even though we cannot actually see it, we know it comes through pipes, and we can smell it, feel its pressure, measure its volume, and if necessary weigh it. The amount of gas (of a given composition) we receive, in terms of the heat or power it can give, is not its volume, nor its pressure. If it were delivered in high-pressure steel cylinders instead of through a gas main, the volume could be much less. Actually, given constant temperature, the amount could be measured in units of volume × pressure. But, you may say, surely the household gas meter measures only its volume, in cubic feet? Quite so; but this is allowable because gas is always delivered to the home at atmospheric pressure plus about one per cent, and for this purpose it is assumed that the variations above and below atmospheric pressure (and temperature) cancel out. The electrical people might assume that their pressure was, on the average, constant too, and install meters taking account of current and time only, but fortunately for us in these days, when the variations are always downward, they don't.

The reckoning of gas supply could be further elaborated into pressure, volume per unit of time, and time. The point in doing so is that volume per unit of time (say cubic feet per hour) is the analogue of electric current, which is the *rate* at which electricity flows, not the quantity that flows. And so we have the following comparison, in which I have also listed some possible units:

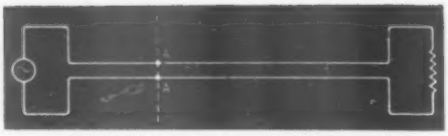

Fig. 1. The dotted line marks any chosen boundary at some stage along a feeder joining a generator to a load. The energy leaving one side of the boundary must always equal that entering the other side.

(Just in case somebody coming fresh from last month's issue cannot resist calculating the dimensions of the rather complicated final unit of gas and finds the result is not mass, I would remind him that there is the hidden assumption of constant temperature.)

I hope that by now energy has lost a little of its abstractness and can be clearly visualized as the most practical measure of electricity. If so, I will go on to suggest that it is helpful to do so, not only in commercial transactions with the B.E.A., but also in studying communication circuits and transmission lines. Such studies are apt to be carried out in an atmosphere of abstract mathematics, or, failing that, not at all. But if one hangs on firmly to the idea that energy is something definite, sold at a penny a unit, a mental picture may emerge from the mists.

To take an example; when gas is delivered through a pipe, there is no difficulty in grasping the fact that the supply has first to occupy the pipe before it can be received at the far end. The greater the pressure of the delivered gas supply, the greater the amount of gas needed to fill the pipe. Something of the same kind happens when goods are first released by the manufacturers; it takes time to fill the "pipe-line" of distribution before they are generally available. So it is not surprising if corresponding conditions apply to electrical transmission. If one starts to push electrical energy into one end of a line it first has to fill the line before any can be delivered at the far end. And the greater the delivered pressure—voltage—the greater the amount of energy *en route*. The same applies when signals are radiated through space, with no line. And although electrical energy travels at such a high speed that the delay is hardly noticeable, the "pipe-line" effect may be important even in such things as amplifier circuits. So the subject really is up our street after all.

If you have been thinking about the line you may well ask how electrical energy can exist while it is in transit along it. Fig. 1 represents a line joining a generator to a load, and for the sake of argument we can assume the resistance of the line itself is negligible. If an imaginary partition is erected anywhere, say at AA, it is easy to see that multiplying the voltage across

Gas	Electricity
Pressure—lb per square inch	E.m.f.—volts
Rate of flow—cu. feet per hour	Current—amps (= coulombs per sec)
Time—hours	Time—seconds
Useful amount delivered = mass—lb/sq. in × cu. ft/hr × hours	Useful amount delivered = energy—volt-amp-secs = joules

AA by the current flowing through the wires gives the rate of energy flow from one side of the partition to the other. But with zero line resistance there is no voltage drop actually along the line itself, so one might think that as current multiplied by zero voltage equals nil there is no energy in existence along it.

This consideration applies equally to d.c. and a.c., but so as not to make things unnecessarily difficult let us say d.c. The current flowing along the line sets up a magnetic field. And here, of course, one runs into the question of what exactly is a field. I am not going to attempt to answer that question rigorously, but seeing we have been using a material analogy, it is perhaps fair to liken the energy stored in a magnetic field to the energy stored in any material substance set in motion (i.e. kinetic energy). The energy stored in a railway wagon when the shunting engine sets it in motion is capable of carrying it quite a distance against frictional opposition. The gas flowing along the pipe, even, has some kinetic energy, but since this is not the kind of energy that gas is actually supplied for, you had better not press that part of the analogy too far.

The line is, in effect, a coil having one turn; and although the coming and going wires are close together, so that the magnetic fields set up by the currents in them tend to cancel out, there is bound to be some field so long as the wires do not completely coincide. It is not very simple to demonstrate the storage of energy in a line, but if a heavy current is passed through a large iron-cored coil, and the coil is suddenly open-circuited the stored energy tends to keep the current flowing, and there is a formidable flash. If the resistance of the coil were negligible and there were no such thing as a magnetic field, then no appreciable voltage could be set up between its terminals by any amount of current, so no energy could enter into it. But, as can easily be demonstrated, when the current is switched on there is, for a few moments, a considerable back-voltage, and it is the product of the supply voltage needed to overcome it, and the current, and the time taken to establish the current, that is a measure of the energy stored in the magnetic field; and it is this energy that is suddenly released when the coil circuit is broken.

The same applies on a smaller scale to the line; before a current can be established in it from end to end, a certain amount of energy must be devoted to setting up a magnetic field around the wires.

Storage in an Electric Field

But that is not all the pipe-line storage. Any difference of potential between two points sets up an electric field in the space between the points. Just as a certain voltage is needed to set a current going (even when there is no resistance) because of the back-voltage induced by the magnetic field, so a certain current is needed (over and above that supplied to the load) to establish a p.d. anywhere. This is the capacitive or charging current. So even if the load terminals of the line were open-circuited, some current would have to flow temporarily into the line in order to establish the generator voltage across it from end to end. This storage of energy can be demonstrated by charging a large capacitor to a high voltage and then (after having disconnected the charging source) short-circuiting it. Again there is a formidable flash. The mechanical analogue is the motionless energy called potential energy which internal pressure creates in a balloon by distending it, or can be stored by compressing a spring or raising a weight. The energy due to the line voltage is stored in the space between the wires as an electric field.

So we find that none of the energy travelling along a resistanceless line exists in the wires themselves; it is entirely in the space around. This may surprise some people. But it surely makes it easier to visualize how energy can travel from place to place without a line at all, as in radio transmission.

It is only when a line or circuit has some resistance (as, of course, it always does) that electromagnetic energy enters into it from the surrounding space. It is then converted into heat energy.

If the d.c. generator is replaced by a high-frequency alternator, each cycle pushes a definite wad of energy into the line, and these wads travel along it. When the wires are close together, so that the capacitance is large and the inductance small, a given voltage requires a relatively large amount of current to recharge the capacitance in opposite polarity each cycle; and a large ratio of current to voltage means a low impedance. Provided that the load resistance matches this, all the energy will be absorbed by it and converted into heat; but if not, some of it is bound to return, and it is the resultant of the energy travelling in both directions at once that sets up standing waves along the line. But that is another story.*

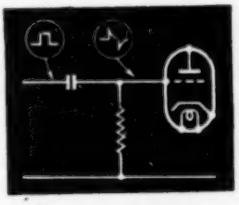

Fig. 2. Example of a circuit in which the intended result is modified by the energy demands of capacitance and inductance.

While it is easy to see that there must be pipe-line energy along a transmission line, it may not always be realized that the same effect can be important in quite concentrated circuits. Even the shortest length of wire needs some charging current to establish a voltage across it, and current flowing through it sets up some magnetic field and so generates an opposing voltage. The delay caused by having to fill up a "pipe-line" consisting of a lead to a valve grid may be perhaps one hundred-millionth of a second, which can be neglected at audio or low radio frequencies, but alters the whole behaviour of the system at television frequencies, because by the time one cycle has been completed at the input it is only part-way at the output. So if, perhaps, negative feedback is attempted, at very high frequencies it may be veering towards positive feedback, with undesired results. In other words, the brief fill-up delay causes a serious phase-shift.

Fig. 2 is an example—a "differentiating circuit" for converting square waves into peaks, as shown by the little waveform diagrams attached. Ideally the waveform reaching the input of the valve has a perfectly vertical front—or at least as vertical as the original square wave—because a series capacitance communicates an applied potential difference instantaneously. But if one is attempting a really steep front one must not overlook the fact that the grid of the valve is a

* "Standing Waves on R.F. Cables." August, 1950.

small capacitor, and this has to be filled up with energy before the wave voltage can be established.

At v.h.f., too, the wires connecting the valve electrodes to the pins have appreciable inductance, and the energy taken in by the magnetic field may have a very profound effect on the working of the valve.

Audio frequencies are low enough for these undesirable effects in the circuits to be be avoided unless one is very careless, but it is not so when the electrical energy is transformed into mechanical energy in the loud speaker. If it were possible to make a diaphragm having rigidity without mass all would be well; or nearly all, anyway. The vibrations applied at the centre of the diaphragm would affect all parts of it at once, so the whole would be in phase. But, as things are, quite a lot of kinetic energy has to be imparted to the cone before it will all move, and by the time it has been "filled up" the drive has begun the next cycle. So the outer parts lag behind or may even be moving in direct opposition to the centre, and things become very complicated.

Electrical filters, of course, are essentially energy traps. As far as possible they are made without resistance, so clearly they are not intended to waste energy in themselves. The idea is to pass energy at some frequencies freely and throw back energy at other frequencies, somewhat as a coffee filter lets the liquid through and holds back the grounds.

Every impedance (in the widest possible sense of the term) can be expressed as a resistance plus a reactance. Both resistance and reactance can be either positive or negative. An impedance which consists of a positive resistance ($+R$) is one which takes in electrical energy and does not give it back. If it is a resistance in the narrow sense, the energy goes as heat. In the broader sense of resistance it may go as radiation or iron-core losses or mechanical energy developed by a motor. A negative resistance ($-R$) is one that gives back energy without taking it away; for example, an amplifier with positive feedback. It is capable of setting up oscillation in a positive resistance connected to it; in other words, it gives energy in the form of a.c. Reactance is the kind of impedance that accepts energy as a short-term loan, but hands it back in its original form at the first opportunity. A spring has mechanical reactance, because if you feed it with energy by pushing or pulling, it hands you back the energy as a counter push or pull. "Positive" and "negative" applied to reactance do not signify the same thing as when applied to resistance. They are an arbitrary means of distinguishing between energy stored in a magnetic field—inductive reactance, $+X$—and energy stored in an electric field—capacitive reactance, $-X$.

So we see, then, that the four kinds of impedance, $+R$, $-R$, $+X$, and $-X$, indicate what is happening to the electrical energy. Most impedances—strictly speaking, all impedances—include both resistance and reactance, so that when energy is flowing there is a permanent transfer to or fro combined with a cycle-by-cycle exchange to *and* fro.

Tying Up the Ends

I hope I have made quite clear the oft-confused distinction between energy and power. For example, if a capacitor is charged very slowly the power employed is very small. But if it goes on a long time the total energy may be considerable, because energy is power × time. Now if the capacitor is discharged suddenly, the power of the discharge may be enormous compared with the charge. This does not mean that the capacitor is giving us something for nothing; the *energy* given back can be no more than that put in. The different rates of charge and discharge are quite incidental beside the great principle of conservation of energy.

There is just one other thing that sometimes confuses; *work*. If energy is capacity for doing work, then work can be—and is—measured in the same units. Work can be regarded as the effect produced by energy. They are just two aspects of the same thing, much as a punch on the nose is one thing with two aspects. The "work" aspect is the ruin of the victim's face; the "energy" aspect is the effort put forth by the aggressor. In electrical circuits, energy is associated with e.m.f.; work with p.d. We went into the distinction between those in the December, 1950, issue.

Let me finish by summarizing the advantages of thinking in terms of energy:

(1) Voltage can be traded for current or time—these factors are often stepped up or down merely as a matter of convenience; the one thing for which there is always an exact balance-sheet of "in" and "out" or "before" and "after" is energy.

(2) In terms of energy one can follow a transaction beyond the confines of the electrical circuit, without even needing to change the unit of measurement.

(3) Because energy includes the time factor, and time is the inverse of frequency, the differences in performance at different frequencies largely explain themselves.

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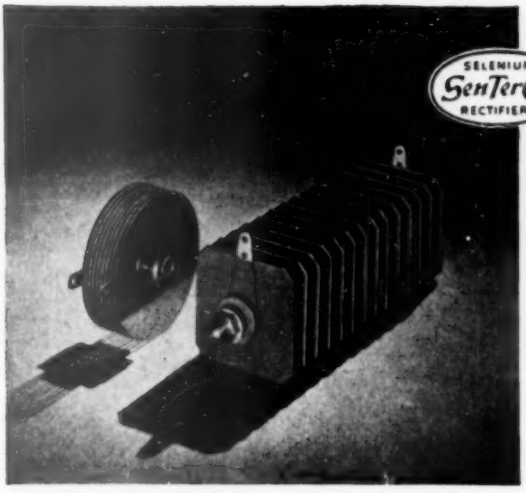

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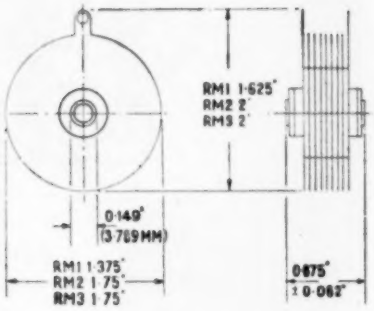

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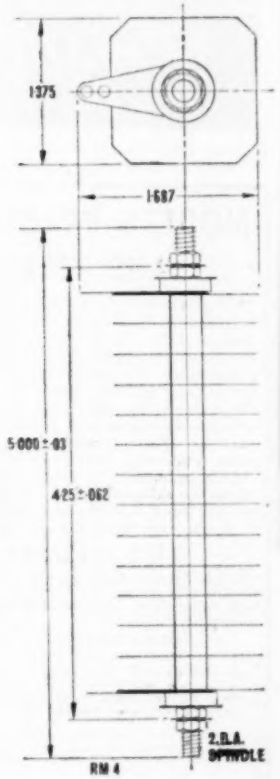

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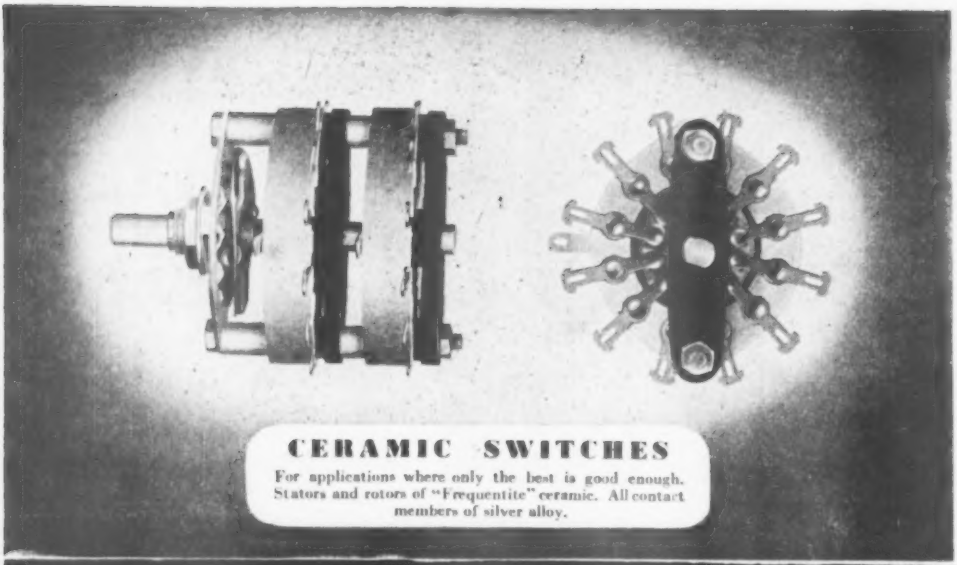

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Receiver Designed for Subjective Comparison of the Two Systems

WHEN the B.B.C. decided to carry out tests for comparing the relative merits of the f.m. and a.m. systems of modulation for v.h.f. broadcasting, it was realized that for a true comparison a special receiver would be required.

A performance specification was accordingly prepared and R. N. Fitton, Ltd., makers of Ambassador sets, undertook the design and production of the receivers. Some of the requirements in the specification were extremely exacting; it is not proposed to enumerate them here as they were given in a paper by F. H. Beaumont, read at the 1951 Radio Convention held by the British Institution of Radio Engineers, and to be published in the institution's *Journal*.

Admittedly this receiver is very specialized but it includes a number of circuit features which might, with advantage, be embodied in a f.m. receiver when a better-than-usual performance is desired. There are also a few interesting a.m. circuit details.

Before dealing with these a brief description of the Ambassador Comparator A.M./F.M. Receiver, as it is called, might be of some interest. In order to ensure a true comparison, be it of modulation systems or anything else, as much as possible of the equipment should be employed for all the tests.

In an a.m.-f.m. receiver it is possible to make a very large part of the set common to both systems, although it may happen that in some cases the actual arrangement might not be the one that would normally be employed. For example, with ±75kc/s deviation in the f.m. transmission the receiver's bandwidth has to be considerably wider than would be needed for an a.m. transmission of comparable fidelity. There is, however, no very serious objection to using a bandwidth wider than necessary for a.m. provided the signal-noise ratio does not exceed a pre-determined value. That has been looked after in the specification of this receiver.

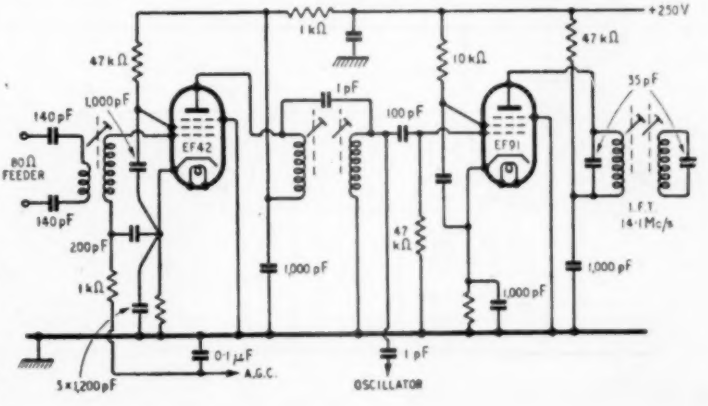
The general circuit arrangement consists of one broad-band r.f. amplifier, separate mixer and oscillator, a.f.c. stage, three i.f. amplifiers centred on 14.1 Mc/s, a.g.c. diode (a.m.), two limiters (f.m.), impulse noise limiter (a.m.), a.f. amplifier and output stage. Two full-wave rectifiers are used in the h.t. supply unit. With the exception of the output valve all are miniature all-glass types.

For the discriminator the well-known Foster-Seeley circuit was chosen. This choice was greatly influenced by the fact that a carrier-generated d.c. voltage is available for automatic control of the oscillator frequency.

Although the tuning range specified was 87.5 to 95 Mc/s it was felt that this could be covered in the r.f. stage by wideband couplings, so avoiding the complications of ganging. An r.f. pentode, the Mullard EF42, is used with a single tuned circuit on the input side and an inductively coupled pair, assisted by a little top-end capacitance, on the output. Provision is made for use of a balanced aerial feeder, not a coaxial, and each lead is joined to the grid circuit coupling coil through a 140-pF capacitor.

In the r.f. stage the de-coupling capacitors consist of several miniature ceramics joined in parallel in preference to a single capacitor of larger physical size. For example, the cathode resistor by-pass capacitor consists of several miniatures totalling about 4,000 pF, a value larger than would be thought necessary, but which has been found to give an improvement in the spurious response ratio. By connecting one of the cathode by-pass capacitors to a point on the bias resistor lead slightly displaced from the others, a broadly tuned rejector circuit effective over the image frequency band is obtained, but it is an arrangement that may not always be satisfactory. The r.f. part of the circuit together with the mixer valve, is shown in Fig. 1.

Fig. 1. R.F. and mixer stages of the Ambassador A.M./F.M. Comparator receiver.



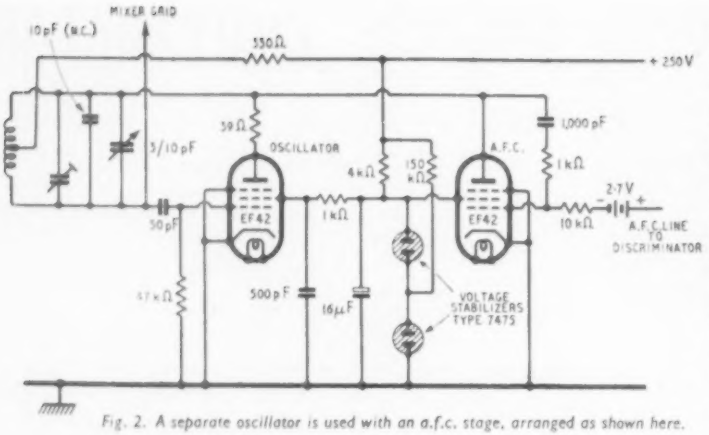


Fig. 2. A separate oscillator is used with an a.f.c. stage, arranged as shown here.

A Colpitts is used for the local oscillator, the only unusual feature being that the valve is a pentode and not the customary triode. The oscillator is placed on the high-frequency side of the carrier and covers 101.5 to 109 Mc/s, it was felt that interference from image signal responses would be less troublesome from the higher image signal band of 115.5 to 123 Mc/s than from the lower one of 59.5 to 67 Mc/s.

Apart from initial frequency drift on warming up any subsequent wandering of the oscillator is corrected, when tuned to a signal, by a reactance valve joined across the oscillator tuned circuit, which behaves as a variable inductance. Control voltage for this valve is derived from the discriminator.

Since control is affected by varying the grid voltage of the reactance valve the inclusion of a cathode resistor for standing grid bias was considered undesirable as it would introduce some degeneration and limit the range of control available. The grid bias is therefore obtained from two mercury-type dry cells in series with the a.f.c. voltage supply line as shown in Fig. 2.

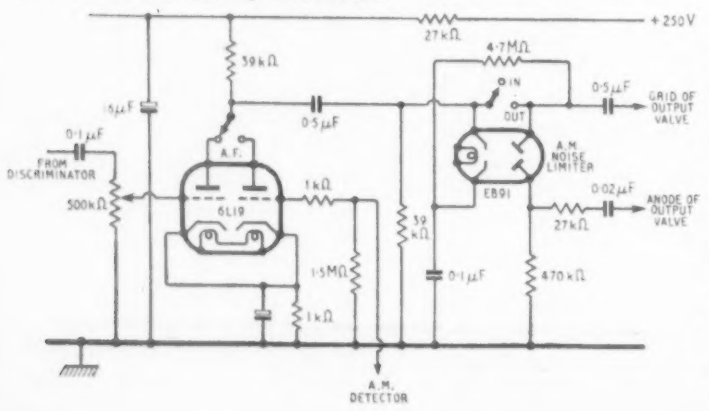
Further measures taken to correct for frequency drift consist of the inclusion of a negative temperature co-efficient capacitor in the oscillator tuned circuit and a stabilized voltage supply to the screen grids of the two EF42 valves.

The a.m. impulse noise limiter is the type which follows the modulation and lops off all peaks of noise which exceed the instantaneous modulation level. It was developed by Murphy Radio and consists of a diode inserted in the audio path between a.f. and output valves with the signal applied to the cathode. It is held normally in the conducting state by a positive potential on the anode obtained by rectifying a part of the audio signal at the anode of the output stage.

In order that the anode of the series diode shall follow normal modulation changes it is given a time constant of about 10μ sec, and the positive anode voltage is just sufficient to maintain it conducting at all normal signal amplitudes. When a strong noise pulse arrives the cathode potential rapidly goes very positive, but owing to its lower time constant the anode cannot follow so quickly and the diode opens and signals are cut off from the output valve.

It is convenient to include both diodes in one valve and in this case an EB91 is used, the circuit arrangement being shown in Fig. 3 which includes also the audio amplifier. This stage is a little unusual as it employs separate triodes for the a.m. and f.m. signals, but for convenience they are embodied in one valve. Both anode circuits feed into a common load, which is joined by the a.m.-f.m. changeover switch to one or other as required. This arrangement avoids breakthrough of signals from the unwanted system and enables the audio inputs from the two channels to be adjusted to the same level and overcome the troubles often encountered with switching in the grid circuit.

Fig. 3. Principal features of the a.m. noise limiter, which follows the modulation, is shown here. The twin-triode audio stage is included also.



Manufacturers' Products

New Equipment and Accessories for Radio and Electronics

E.H.T. Indicator

A HANDY instrument for measuring e.h.t. voltages on television cathode ray tubes has recently made its appearance. Called the "Kilovolter," it is actually a variable-width calibrated spark-gap enclosed in a tube fitted with test prods. In use, the spark-gap electrodes are screwed together until a flash-over occurs, then the position of the moveable electrode on a scale gives the number of kilovolts necessary to break down that width of gap. The instrument has a range of 3 to 30 kV and can be used on line-flyback, r.f. and pulse e.h.t. systems (a series resistor is necessary in the measurement of mains-derived supplies). It is produced by Waveforms Ltd., 26 Oakleigh Road, New Southgate, London, N.11, at a price of £3 17s 6d.

"Kilovolter" by Waveforms Ltd.

Extension Loudspeaker

NOTABLE for its low price is the new "Bonnie" Baffiette extension loudspeaker produced by Richard Allan Radio Ltd., of Taylor Street, Batley, Yorkshire. Although the loudspeaker itself is only a 5-in model it has quite a high maximum power input—1.5 watts. It is provided with a volume control and is built into a semi-baffle type of cabinet measuring 8½in × 6½in × 3in. The price is £1 19s 6d, with 8s 6d extra if a transformer is required.

Soldering Flux

FOR jobs in which it is preferable to use solid soldering wire rather than resin-cored solder, H. J. Enthoven & Sons Ltd., of 89 Upper Thames Street, London, E.C.4, have brought out a new liquid flux called "Telecene." It consists of high-quality resin dissolved in methylated spirit and contains an activating agent similar to that used in the Superspeed "White Flash" resin-cored solder made by the same firm. The flux is claimed to be particularly effective in mass dip-soldering operations.

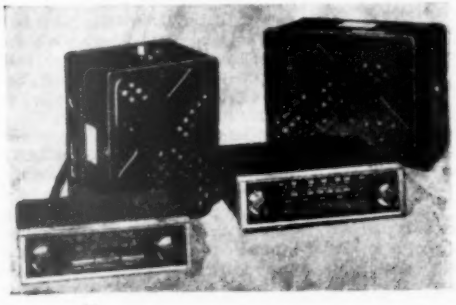
Car Radio Units

H.M.V. car radio receivers are now constructed as a series of units, from which a number of different sets may be assembled. For the home market there are two control units covering medium and long waves and allowing for both free tuning and push-button selection of a limited number of stations.

One control unit (on left in illustration) provides preselection of three stations and just behind it is the smaller of the two amplifiers (Type A). Together these make up a five-valve superhet capable of working one loudspeaker at good volume and quality.

The other control unit gives choice of four medium-wave stations and one long, also free tuning. Behind it is the Type B amplifier and these two form an eight-valve superhet capable of giving sufficient audio power for two loudspeakers. Either control unit can be used with either amplifier.

The eight-valve installation costs £22 12s plus purchase tax of £11 6s. Alternative control units covering medium and short waves are available for overseas markets. The makers are S. Smith and Sons (Radiomobile), Ltd., 179-185, Great Portland Street, London, W.1.



With these four basic units a range of "H.M.V." car radio sets can be assembled for the home market.

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RANDOM RADIATIONS

By "DIALLIST"

A.M. Versus F.M.

THE B.B.C.'S REPORT on the results of the Wrotham experimental transmissions has come out strongly in support of f.m.'s claim to be the better system for broadcasting on the metre waves. So far as I can see, the comparative tests of a.m. and f.m. were absolutely fair. The transmissions were made simultaneously from the same aerial and with the same output power. The results obtained were judged not only by field and laboratory tests, conducted by engineers, but also by the reports from numerous listeners, many completely non-technical, who had been provided with receiving sets of the same standard design. Frequency modulation was found by far the best against both receiver hiss and motor ignition interference. To provide a first-class service (no interference from 50 per cent of cars passing within 30-60 feet of house; none to give rise to interference that is more than "slightly disturbing") a.m. must have about ten times the field strength of f.m.; f.m. can give a second-class service (interference from 50 per cent of cars no worse than perceptible; from a few cars interference may be disturbing) with a field strength of only 0.25 mV/m. The service area of a 25-kW f.m. transmitter is much the same as that of a 100-kW station working on the medium waves. For a country-wide v.h.f. service four times as many a.m. stations as f.m. would be needed.

No Doubt About It

We may say, then, that f.m. comes out the winner of the contest by a very handsome margin from the engineers' point of view; but that is by no means all. The financial considerations are equally important, and the smaller number of transmitters required means lower initial outlay, reduced running costs and smaller manpower demands. And what of the listener? So far as he is concerned the B.B.C.'s report contains two very considerable surprises. The first is that, though the f.m. receiver may cost a bit more than the a.m., this is very largely offset by the much simpler aerial system needed; an indoor aerial, in fact, will often suffice for f.m. reception where it would be quite inadequate for a.m. We have been led to believe that the f.m. receiver's alignment would require frequent attention by the serviceman and that oscillator creep would play havoc with reception unless expensive precautions were taken against it. Neither of these things was found to occur in practice. The B.B.C. found that ordinary folk had no difficulty in handling their sets and that if there was slight mistuning its effects were no worse than on the medium waves.

A Television Problem

THERE'S A STORY (true, I believe) of a professor who proved conclusively by mathematics of the most advanced kind that it was absolutely impossible for anyone to drive a golf ball more than a certain number of yards. Whereupon, his son picked up a club and a ball, went out on to the near-by links, teed up and drove a beauty a long way further than the calculated limit of possibility. My reason for telling the story is that something of the same kind seems to be going on in television to-day. People who went to the recent television show in Paris are generally agreed that it was a case of 819 lines first and 441 lines nowhere in it. This does not quite fit in with the calculations that most of us have met with in print or made for ourselves; for these appear to show conclusively that 441 lines, or our 405, should provide the domestic viewer with just about as high a degree of definition as his eye can make use of. Are the calculations really in error? I don't think that they are. I gather that what most impressed visitors who saw 819-line and 441-line images appearing simultaneously on screens placed side by side was the absence of lininess in the high-definition system.

Lininess and the Viewer

People differ a great deal in their reactions to imperfections in both aural and visual reproduction. Many folk, for instance, can make themselves more or less unconscious of needle-scratch when listening to a gramophone playing records. Others find the scratch so offensive to the ear that it is impossible for them to listen to any disc recording with genuine pleasure. In the matter of television lininess few are able to disregard the lines when sitting close to the screen. The great majority of viewers find them so trying that they are compelled to move back from the screen, sometimes to such a distance that they find the image ill-defined. Hence my feeling that it was comparative absence of lininess, rather than better definition in the image, that prompted visitors to the Paris television show to plump so overwhelmingly for 819 lines. I am still not convinced that 405-line television could not give us all the definition we wanted, if only it were sufficiently "unliny" to let us sit close enough to the screen to take full advantage of that definition. There are several possible ways out of the difficulty. The most promising that I have seen is spot-wobble and I simply cannot think why more television receiver manufacturers have not incorporated it in their sets. It is not an expensive addition but it does make an immense difference to the pleasure that a viewer can get from his television receiver. With spot-wobble more widely used, I do not think there would be much call in this country for more than 405 lines, particularly when the increased cost of the high-definition receiver is taken into account.

Thermal Fuses

A FRIEND ASKED ME the other day how he could obtain a small amount of some metal suitable for making those thermal fuses about which you have no doubt read in *Wireless World*. Had it been twenty-five years ago, I would have suggested his trying the nearest wireless shop and asking for Wood's metal, which was used a great deal for mounting the crystals of the old catswhisker receivers. I really do not know where you can buy it nowadays, except, possibly, from shops which specialize in laboratory materials. Luckily, though, I was able to find a piece in my junk box and he went away happy. His request set me thinking, with the result that I made up a very satisfactory thermal fuse from odds and ends I had by me. In my young days, such imps of Satan as numbered me amongst them could buy quite elegant teaspoons made of Wood's metal from toyshops. I cannot help feeling a mite sorry for those of the younger generation who have never witnessed the embarrassment of some pompous afternoon tea guest when he or she found, after a stir or two,

that nothing but the handle was left of the "silver" spoon.

Fusible Metals

There are quite a number of fusible metal alloys and it occurs to me that some readers may care to try one or two of them for making very low-temperature thermal fuses. The melting temperatures are in brackets. Wood's metal (66°-71°C) is: Bismuth 50%, lead 25%, tin 12½%, cadmium 12½%. Lipowitz made the following alloy (55°-60°C): Bismuth 50%, lead 25%, tin 14%, cadmium 11%. By adding mercury (if you can get it these days!) to Lipowitz's recipe, the melting point may be brought down to as low as 45°C, or 113°F. You can also much reduce the melting temperature of Wood's metal in the same way. All fusible metals reach a pasty state sometime before they actually liquefy. Provided that the spring arm of a thermal fuse is of fairly stiff metal, the contacts fly apart cleanly as soon as the pasty state is reached. When you fix the contacts together it is necessary to use sufficient heat to make the metal run freely. If you don't do this, it will not "wet" the contact points and you will get a typical dry joint.

Iodized Layers

A PERTH READER is kind enough to send me a cutting from a Scots newspaper containing an article on the unsatisfactory conditions for broadcast reception which appear to prevail in the north. It contains some startling new ideas about the behaviour of the Heaviside layer which I feel it is my duty to pass on at once to other readers. First, the said layer consists of iodized air—was the article, perhaps, dictated at a time when its author was suffering frob a code id the dose? The effects of iodization are remarkable, as might well be expected. During the day, it appears, the great height of the layer gives the broadcast signals that reach it heaps of elbow room; but with the approach of darkness it descends and kind of squashes them together, with the result that mutual interference occurs between this station and that. Whereupon Caledonia ceases to be merely stern and gets wild. The writer is nothing if not fair-minded; despite all its faults, he assures us, the B.B.C. is not responsible for iodizing the upper air or for the dire things that happen to Scottish listeners as the result of this awesome photo-chemical reaction.

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A full range of front coloured GLASS lenses is available, users of *Neon* lamps will, of course, avoid *green* and *blue*. Plastic lenses are not supplied for this model. Add colour of lens required to List No. when ordering. These Signal-lamp fittings have highly polished black moulded bakelite front bushes and screw-on bezels, with non-ferrous metal body, crackle-black finished and bakelite lamp-holder, with terminal-shroud. Normal colour and finish is BLACK. The Iron moulding can be supplied, *to quantity orders*, in any normal available thermo-plastic colour. These fittings are adequately louvred for ventilation, but are light-trapped so that, used side-by-side, they will not cross-light each other, thus avoiding false signals. Suitable for all mains-voltage uses and in all types of apparatus and equipment, with standard, normal, easily obtained lamps. The use of coloured lamps (15 W. pigmy sign-B.C.) may be contemplated with colourless or white lenses; this (as with a neon lamp behind a colourless lens) gives excellent contrast between lit and unlit conditions, and avoids false signals due to stray outside or room lighting. Fixing screws are concealed by lens-bezel. Size: 2.822" ø × 4⅝" (71.2 mm. ø × 119 mm.). Front of panel projection 1⅛" (37.3 mm.).

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Old Idea Rehashed

I WONDER if you recollect a pre-war receiver designed to stop women provoking their husbands to homicidal mania with the cacophonic results of their "eccentric" tuning. Some set makers tried to mend matters by incorporating luminous tuning indicators to which, in order to appeal to the psychology of women, they gave such names as "Aladdin's Lamp" and "Magic Eye." But the maker of the set I have in mind showed true genius when he designed a set which, if tuned off centre, pulled itself into correct adjustment electronically.

Murderous thoughts.

Unfortunately, the set is no longer made as it was found to encourage betting among men, because, if it were tuned between two stations, it was a matter of speculation which one would pull it into resonance. But, evidently, one of its designers must be in the U.S.A., as the same broad principle has been applied to something else which can, I think, best be described as an electronic juke box. All you have to do is to whistle or hum a tune at the device and it at once orchestrates and amplifies it and so fills the air with its cacophony.

Where it resembles the woman's receiver is that it takes account of the fact that, just as women can't tune a set correctly, few men can whistle or hum a tune in a manner which does not inspire murderous thoughts in the musically minded. I well recollect, many years ago, inspiring such feelings in one who was normally of a gracious and kindly disposition, as I was, so he said, usually a semi-tone flat. This new make-your-own-music device, as it has been called in some quarters, corrects the flatness or other musical outrage of the whistler or hummer and turns his feeble efforts into a full-throated melody which Caruso himself might envy.

Watts in a Name

MUCH as I like correct nomenclature, I cannot altogether support the protest of a correspondent in a recent issue against the use of the words wattage and amperage as synonyms for power and current respectively. I myself greatly prefer the word "faradage" to the new-fangled "capacitance" which has come into use of late years. Electrical engineers talk glibly enough of a "wattless current"; they do not speak of a "powerless current" which would, I suppose, be the more pedantically accurate term.

No doubt it was a wattless current that the Lord Chief Justice had in mind when, summing-up in a recent case, he told the jury that it was the duty of the Electricity Board to supply the public with "power and current"; at any rate, I cannot see what else he could have meant, although I certainly did not know previously that it was a legal obligation of the Board to supply it.

Radiæsthesia

THERE was a time when *Wireless World* took a pride in the fact that it was a journal "covering every wireless interest" and boldly carried this proud slogan on the cover of every issue. In those days I should have had to look no farther for information on any radio subject no matter how seemingly trifling and insignificant.

To-day, however, although I feel sure that the old spirit of wireless catholicism still hovers over the Editorial desk, the ramparts of radio have become so far flung that quite important matters are, of necessity, denied a hearing. It is for this reason, I think, that we have not had a single authoritative article on the subject of radiæsthesia. Even "Cathode Ray" who, month by month, guides our faltering footsteps up the forbidding slopes of Mount Parnassus, has not turned his all-revealing beam on the subject.

Now many of you will probably ask "what is radiæsthesia?" I must confess that I should very much like to know myself. I have just been wading through a Belgian monthly publication which calls itself *La Radiesthesie Pour Tous*, and in its sub-title informs me that it deals with "Teleradiesthesie" as well. The fact that I am not much the wiser is not necessarily an indication that my knowledge of French does not extend beyond the limits of "Your beer no bon, Mademoiselle"; for no matter how perfect his knowledge of English, a chance visitor from Mars, who had never heard of wireless, would not find a clear definition of it if he picked up an odd copy of *W.W.*

It has been suggested to me that, among other things, radiæsthesia embraces water divining. If that be so, I am entitled to call myself a radiæsthetist, for I have exceptional sensitivity as a dowser. In fact, I have suffered considerable embarrassment at times when seated among my fellow guests at one of those cultural uplift parties given in Chelsea, as my umbrella, which has a hazelwood shaft, often shows signs of violent agitation when the Third Programme is switched on and even turns inside out if the programme be exceptionally "wet."

So far as I can gather, radiæsthesia is a blend of personal d.f. and psychometry in which slotted aerials, such as the B.B.C. uses for f.m., are employed side by side with Kallenberg's Pendulum, used of yore by Madame Estelle and others to determine the sex of unhatched eggs and suchlike things.

To sum up I extend an invitation to any student of this esoteric subject to give a succinct definition of it and a brief account of its *modus operandi*. Provided that it is treated seriously and in a knowledgeable manner, the Editor will, I know, give it the same publicity as he did to a letter during the war which showed how the sunspots foretold Hitler's downfall.

Unusually wet.

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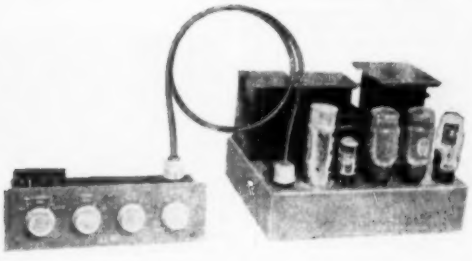
This illustration shows the RC/PA/U pre-amplifier mounted in a console cabinet designed for armchair operation. The TL/12 amplifier is mounted in the base of the cabinet. The Leak Dynamic pick-up and Leak radio unit are also incorporated. This console was presented to Harold Rawlinson, Esq., conductor of the Insurance Orchestral Society, on the occasion of the Society's Silver Jubilee.



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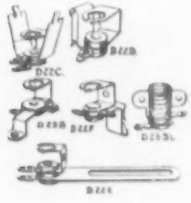
1 tapped 20 watt resistor, vitreous covered ;
6 paper condensers, .05 mf. 1,000 v. working.
3 paper condensers, .1 mf. 1,000 v. working ;
2 H.F. chokes ;
4 paper condensers, .1mf. 450 v. working ;
2 paper condensers, .15 mf. ;
5 bakelite moulded mica condensers .001 ;
1 paper condenser, .01 mf. 3,000 v. working ;
24 rubber grommets, assorted sizes ;
6 resistors 1 watt, all useful values ;
6 resistors ½ watt, all useful values ;
40 resistors ¼ watt, all useful values ;
40 silver mica condensers assorted values, including 10, 15, 20, 40, 50, 100, 150, 300, and 500 pf. types ;
4 English octal valve holders ;
2 English 5-pin valve holders ;
1 E.F. 50 type valve holder ;
3 diode valve holders ;
1 louvred casing, size 12 × 7 × 4in. ;
1 heavy metal chassis size 12 × 7 × 2in. ;
8 condenser clips, assorted sizes.

Also an assortment of nuts, bolts B.A., self-threading screws tag boards chassis mounting tag connectors, screened grid caps, plain grid caps, levers, rollers, connecting rods, output sockets, etc., etc. ALL THIS COLLECTION OF PARTS FOR 6/6 only, plus 1/9 postage and packing.

LAMP HOLDERS

We carry a large assortment of dial lamp holders. Price 1/3 each. Order by list numbers.



SPRAY GUN

Hand operated, ideal to put the finish on a good chassis, and for respraying valves, etc. (completes the perfect job). Price 15/6, complete with instructions plus 9d. postage.

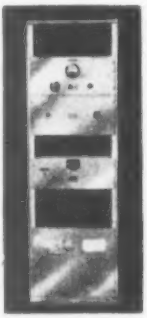
METAL DIVIDERS

Really well made for Government workshops. Ideal for marking out on metal chassis. Price 3/6.

3 WAVE-BAND VALVE SUPERHET CHASSIS

Brand new, tested and ready for immediate operation, full vision scale size 6in. × 8in. covering the long wave 900-2,000 metres, medium wave 185-550 metres, and short wave 16-50 metres. Complete with valves and covered by our six months' guarantee.

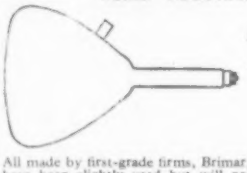
First-class parts, Parmeko mains transformer, Erie resistors, Hunts condensers etc. Special points include (1) Flywheel tuning. (2) Dust cored I.F.'s. (3) Sockets for extension speaker and pick-up. (4) 4 watts output. (5) Coil assembly removable as a unit. Price complete with 8in. speaker £10/10/-, carriage, packing and insurance, 7/6d. extra.



AMPLIFIER RACK

This stands approximately 6ft. high, and was made originally for the G.P.O. The top panel contains the amplifier proper, which consists of an A.C. mains-driven power pack, capable of delivering 200 mA. at 400 v. and, of course, the normal L.T. supplies, and the amplifier itself uses an MHL4 feeder and two PX25s in the output stage, giving approximately 25 watts. This top deck also contains the heavy duty output transformer. The lower panel contains the feeder unit which can be used as a pre-amplifier for microphone and gramophone work. You will observe that on the rack there is ample space for fitting a monitor speaker and an R.F. unit if same are required. Note that the anode current of the PX25 valve is monitored by a 2½in. flush meter. Further note that these amplifiers were made by the famous MARCONI company. Price complete as illustrated but less valves, unused and only very slightly storage soiled, is only £12/10/- each, plus carriage at cost.

THIS MONTH'S SNIP



MAGNETIC T.V. TUBES

From 27/6 each

All made by first-grade firms, Brimar, Mazda, Mullard, etc. They have been slightly used but will probably give years of service.

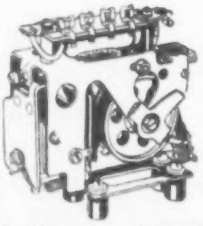
TYPE A. Only fault is low heater to cathode insulation. These will give perfect picture in grid modulated circuits : 9in. price £3/15/- each. 12in. price £5/15/- each.

TYPE B. Have small ion burns but good cathode to heater insulation. Will be quite suitable in any type circuit : 9in. price, £2/15/- each. 12in. price, £3/15/- each.

TYPE C. Have combination of both faults, but will still give reasonable good picture : 9in. price £1/7/6 each, 12in. £2/15/- each.

NOTE.—Callers to our Ruislip branch can see these tubes demonstrated, but whether you see it or not we guarantee a "working" tube.

If not calling please add 7/6 each tube for packing and postage.



REMOTE CONTROL

With only one pair of wires and a simple push button you can select any one of four stations without leaving your armchair. This is just one of the many applications of our impulse relay, the price of which is only 3/9. There are many other purposes to which it can be put we will supply a booklet of circuits for 1/9 post free. The action of the impulse relay is as follows :—current to the solenoid causes the ratchet wheel to rotate one notch per impulse, a built in automatic switch keeps the impulses coming in until they are switched off by secondary contacts which operate four times per complete revolution. Shorting the secondary contacts starts the impulses again. Attached to the ratchet wheel is a four way single pole switch. We are sure that there are many new applications for this relay and we offer prizes for new ideas.

CABLE CLIPS

These cable clips are carefully made for the Navy and are designed so that the edge of the clip cannot cut into the insulation of the cable. In addition to their use for holding cables, these clips are also suitable for fixing back conduit, for fixing T.V. aerial masts to poles or window frames, etc. :—

Depth of Saddle (inches)	Across Saddle (inches)	Admiralty No.	Price each
2	7½	7,000	9½d.
	7¼	7,087	8d.
	3½	3,350	7d.
1½	6½	7,001	8d.
	3½	7,086	6d.
1½	8½	7,005	10½d.
	8½	7,003	10½d.
	6½	7,002	8d.
	6	7,091	8d.
	3½	3,354	5d.
	3	7,090	5d.
1½	5½	7,004	6d.
	3½	7,088	5d.
1½	5	7,095	6d.
	2½	7,094	3d.
	1½	7,083	2d.
1½	6½	7,008	8d.
	5½	7,099	4d.
	2½	7,006	3d.
1	4½	7,013	5d.
	3½	7,016	4d.
	3	7,101	4½d.
	1½	1,100	2½d.
¾	5½	7,106	6d.
	4½	7,102	5d.
	3½	6,105	5d.
	2½	7,104	3d.
	1½	7,103	2d.
⅝	1½	7,107	2d.
½	4	7,111	5d.
	3	7,110	3d.
	¼	3,488	2d.
	⅛	7,112	1½d.

Special quotations to quantity users.

SPECIAL RELAY

Hermetically sealed in glass angle shape and designed to operate when in strong magnetic field, e.g., when near a magnetron. American made, new and unused, price 27/6.

TWO-VOLT ACCUMULATORS

Made for the Forces by one of the most famous firms in the world. 15 amp.-hour size approx. 6in. × 1¼in. square in ebonite case, pre-charged, only need filling with acid. 5/9 each, plus 9d. post and insurance. Six or more post free.

AERIAL STRAINERS

Brass body, price 1/6 each.

PLUGS FOR MODERN VALVE HOLDERS

Each is fitted with a rubber shroud.

Type 1, for B7G button base.
Type 2, for B9A noval base.
Price 1/4 each, discounts for quantities.

TRANSFORMER BARGAINS

All by famous makers such as Parmeko.

200 mA, 340-0-340 v. 6.3 v. at 4 amps, 5 v. at 4 amps, 4 v. at 3 amps, unshrouded but fully impregnated, a really first-class transformer. Price 25/-.

150 mA, 425-0-425 v. 6.3 v. at 6 amps, 6.3 v. at 6 amps, 5 v. at 3 amps, 4 v. at 2 amps, 4 v. at 1 amp. Price 65/-.

150 mA, 350-0-350 v. 6.3 v. at 4 amps, centre tapped, 5 v. at 3 amps, fully shrouded upright mounting. Price 32/6.

80 mA, 300-0-300 v. 6.3 v. at 4 amps, 4 v. at 3 amps, half shrouded drop through. Price 18/6.

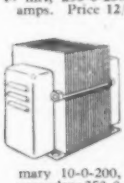
80 mA, 320-0-320 v. 6.3 v. at 4 amps, 5 v. at 3 amps, half shrouded drop through. Price 19/6.

70 mA, 230-0-230 v. 6.3 v. at 3 amps, 5 v. at 2 amps, fully shrouded upright mounting. Price 22/6.

60 mA 260-0-260 v. 6.3 v. at 3 amps, 4 v. at 2 amps, half shrouded drop through. Price 16/6.

60 mA, 260-0-260 v. 4 v. at 4 amps 4 v. at 2 amps. Price 16/6.

40 mA, 250-0-250 v. 6.3 v. at 4 amps. Price 12/6.



A FEW LEFT

Really beautifully made transformers, fully shrouded upright mounting, with plated and polished shrouds.

Type 1. Primary 10-0-200, 220, 240, H.T. secondary 350-0-350 v. at 250 mA, 4 v. at 6 to 8 amps, and 4 v. at 3 to 4 amps. Dimensions are 4in. × 4in. × 4¼in. Price 27/6, plus 2/6 packing and postage.

Type 2. Primary as type 1, H.T. secondary 300-0-300 v. at 150 mA, L.T. 7.5-0-7.5 v. at 3 amps, and 4 v. at 3 to 4 amps. Dimensions are 4¼in. high × 4in. × 3¼in. Price 17/6, plus 2/- postage and packing.

FILAMENT TRANSFORMERS

6.3 v. at 1 to 1.5 amps, standard type for receivers. Price 6/6.

6.3 v. at 1.5 to 2 amps, standard type. Price 8/3.

2 v. at 2.5 amps, highly insulated for television. Price 7/6.

CONTINUOUSLY VARIABLE MAINS TRANSFORMERS

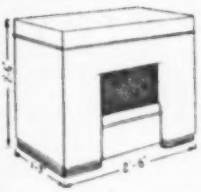
Any voltage from 1v. to 280v. built to "Wireless World" Specification. £3/10/- each.

60 AMP TRANSFORMERS

Suitable for low voltage soldering irons, ground heating, welding, etc. Weight approximately ¼ cwt. Size 7¼in. × 7in. × 6in. The voltage tapping is between 13 and 15 volts with an input of 200-230 v. 50 cycles. Price £3/15/-, carriage and packing 17/6.

RADIO-GRAM CABINETS

Full size console type cabinets with highly polished walnut finish. Designed to take standard type auto change gram unit. You can have these at £12/10/- each which means a really nice radio-gram for less than £30, for we can supply a 5-valve 3-waveband chassis at £10/10/- (minor alterations to the radio chassis will, of course, be necessary). Gram Units: Ordinary from £5/5/-. Auto from £11/15/-. **Special Offer.** Cabinet complete with auto change gram unit and pickup £22/10/-



Please note as our storage is limited, it is as well to confirm that these cabinets are actually at the branch before calling specially for one. Also note we can deliver these only within our van area and delivery charge will depend on distance.

T.V. CABINETS.

For "Viewmaster," etc., are available. Console type £12/10/- and Table Model type, £6/19/6. For more details see last month's announcement.

STAND-BY BATTERY SET

Made originally for the Government for use in canteens, etc., this 4-valve medium waveband superhet uses 2v. Mazda valves, and is complete with 5" P.M. speaker and usual controls. A good set to have by you so that you can carry on listening to a programme despite a power cut. Unused but storage soiled, £4/5/-, carriage 5/- extra.

10,000 B.V.A. VALVES AT PRE-BUDGET PRICES

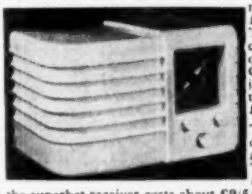
6-VOLT AMERICAN HEAVY-DUTY BATTERIES

Made by one or other of the most famous American battery companies. For reliability and long service between charges these are in a class of their own. Capacity rating is 140 amp-hour. We have a limited quantity of these batteries available, unused—in fact they have never been filled with acid, and the price is £5/10/-, carriage extra at cost depending upon your locality.

PROFESSIONAL RADIOS YOUR CAN MAKE

You will find that the building of our all mains radio receivers is simplicity itself, and the more you make the less time each takes, everything down to the last nut and bolt is supplied, and everything fits together in a professional manner. When finished the receiver looks and plays as well as those being offered in radio shops at anything between £10 and £14.

The one illustrated above we call "The Occasiona" in a choice of colours. Ivory, Walnut or Green, and the T.R.F. costs just less than £6 to make, while the superhet costs approximately £9.



The other radio illustrated we call the "White Lady" this is an extra fine cabinet of pure white. The complete T.R.F. receiver costs about £6/5/- to build and the superhet receiver costs about £9/5/0 to build. Constructional data for either set is available at 1/6 post free.

Orders by post are dealt with by our Ruislip depot. To avoid delay address to Electronic Precision Equipment, Ltd., Dept. 2, Windmill Hill, Ruislip, Middlesex.

DON'T SCRAP IT

You can now recharge your H.T. or combined H.T./L.T. battery from the mains. New invention, the "Activette" will save its cost within a few months. Send £3/5/- for Radio Battery Type or £4/4/- for the Hearing Aid type. Money back if not completely satisfied. If in doubt send S.A.E. for full details and copy of National Physical Laboratory report.

10in. ENERGISED SPEAKER

The resistance of field is 1100 ohms and the construction of the speaker is such that really good response must result. The ideal speaker for a quality amplifier or receiver. Limited quantity. Price 17/6 each, postage and packing 2/6 extra.

TRIPODS

Tremendously strong, but not at all heavy. 3ft. high and with brass male and female thread top. Black japanned pressed steel, unused, but may need repainting. 3/6 each, plus 2/6 post and packing.

PYE PLUG AND SOCKET

6d. each part.

FLEXIBLE COUPLINGS

These are sometimes known as bellows couplings because they will extend as well as bend. They are ideal for joining shafts which are out of alignment and for slug tuning controls where the core has to come in and out. Price 1/9 each.

INDICATOR LAMPS

Complete as illustrated. Price 1/6.

B.A. SOCKET SPANNERS

Covering sizes 0-6 B.A. and with double ended wrench as illustrated. A really good set which will help you with those nuts in awkward corners price 6/6 complete.

REVOLUTION COUNTER

An essential device for coil winding, the type we have count up to 9999. The dial is extra clear and the overall dimensions are 2¼in. × 1¼in. × 1¼in. 8/6 each.

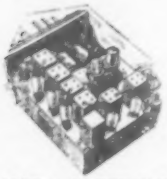
Orders under £2 add 2/6, under £1 add 1/9. Postable items can be sent C.O.D., additional charge approx. 2/6. List 6d.
Early closing days: Wednesday, Ruislip Saturday, City.

ELECTRONIC PRECISION EQUIPMENT

WINDMILL HILL, RUISLIP, MDX. Phone: RUISLIP 5780

152-153 FLEET STREET, E.C.4. Phone: CENTRAL 2833

ELPREQ PAGES



10 VALVE 1¼ METRE SUPERHET

Ideal for conversion into a Midlands or London region Televisor. These contain 6 valves type 2SP61, and one each RL7, RL16, and EA50. Six I.F. Transformers of 12 Mc/s, 4 Mc/s band width, and hundreds of other useful components. Price **59/6**, plus carriage and packing 5/-. These receivers are unused and in original wrappings.

RECEIVER TYPE 78

This covers the wave band 2.4 to 13 Mc/s and it is also fitted with a 100 kc/s crystal with an internal arrangement whereby its oscillator can be accurately checked with the crystal, the sets are complete with 5 valves, and they are brand new and unused. Size is 6½in. × 8½in. × 10in. approx. Price **£4 10 -**, Plus 7/6 carriage, etc.

RECEIVER R.1124

This receiver contains a host of useful stuff, the most important of which is a coil pack which needs only the adjustment of its trimmers to receive AP. sound. It also contains Westectors, resistors, switches and all the parts which make up a six valve superhet. The valves contained are three type 9D2 and one each of 8D2, 4D1 and 15D2. We understand that these receivers have never been used. Price only **18/6** each plus 2/6 postage.

BATTERY CHARGER 21

This is an excellent unit fitted with heavy duty mains transformer and metal rectifiers. Its output is 160-200 v. at ¼ amp., so it is ideal for charging wet H.T. batteries. It can, of course, be used for charging L.T. batteries, in fact it will charge 70 cells simultaneously or any number up to this. In addition to charging cells, this unit can also be used to work D.C. appliances off A.C. mains, or if its output is led into a resistance, network then you can have a source of D.C. for experimenting. The charger works off standard 200-250 mains, and is contained in a neat perforated case, price 22/6 plus 3/6 carriage.

EX-GOVERNMENT CATHODE RAY TUBES

Note—All these tubes have green fluorescence.

5CP1. 5in. electrostatic, American manufacture—medium persistence suitable for T.V. or 'scope, in original cartons, **19/6** carriage and insurance 2/6.

VCR517 6in. electrostatic, medium persistence, suitable for T.V. or 'scope work—unused, ex-new equipment, 22/6 carriage and insurance 5/-.

VCR97. We have had a new delivery of this now famous electrostatic 6in. T.V. tube, these are not the cut off type, they give a full picture. 42/6 carriage and insurance 5/-.

VCR516 9in. magnetic tube, long persistence which makes it rather unsuitable for T.V. Price £2 10 -, postage and insurance 10/-.

VALVES

We believe that we carry larger stocks than any other firm in Middlesex in consequence we can offer most types of Receiving valves at pre-Budget prices, which means a considerable saving of purchase tax. Our stocks are much too assorted to list in these pages, and, as prices are controlled, we suggest you order your valve requirements by C.O.D. or send what you think will cover the order; we will refund any extras. We have never specialised in Transmitting types, but naturally we stock a few of these, and in most cases, being war surplus we can give you a considerable reduction on manufacturers prices. For instance, the one illustrated is a 250-watt Transmitting Tetrode V.T.31, heater rating 12 v. 8 amps; it measures 14in. long and 6¼in. across the bulb. It would cost anything up to £20 from the manufacturer, but we have a limited number to offer at 18/6 each. (Callers only).

TRANSMITTING TYPES

We can offer at low prices.

813 at 110 -; 6J6 at 16/-; ML6 at 10/6; TZ40 at 47/6; 860 at 19/6; 872 at 47/6; RK34 at 12/6; 807 (American) at 18/6; 866A at 21/-.

SPECIAL TYPE VALVES

KLYSTRONS. Type No. CV129 as illustrated. Price £3 each. Type No. 726 AB, Type No. 723 AB Price £6 each. Other types may be available in small quantities. Send details of your special requirements.

GAMMATRON

Triode transmitter type 54, 250 watts R.F. output, filaments 5v. at 5 amps. Price **£1 15 0** each.

HIGH VOLTAGE RECTIFIERS

Being Ministry surplus these are available at really silly prices, This is your opportunity to experiment with that special plant you intended to make.

Type CV19, 63,000 v., max. 800 m.a.	£4 17 0
Type CV1504, 60,000 v., max. 1,200 m.a.	£5 17 0
Type CV74, 40,000 v., max. 600 m.a.	£2 17 6
Type CV1111, 14,000 v., max. 350 ma.	4 3
Type CV1120, 14,000 v., max. 50 ma.	4 3
Type CV1508, 8,000 v., max. 1,000 ma.	17 6
Type CV54, 7,000 v., max. 400 ma.	6 6

10,000 B.V.A. VALVES AT PRE-BUDGET PRICES

MAKE A CONVECTION HEATER

Using Ex-Admiralty HEATING UNITS fitted with 3 pin brass plug and socket. Copper-clad enclosed elements are used and those again are enclosed in sheet metal half cylindrical containers. Fit one of these into a metal cabinet, and you have an excellent convection heater. In places where appearance is not important, all you need extra is the wire as the heaters work perfectly well as they are, without extra casing the actual element being totally enclosed.

PRICES

2 K.W. 220-230 v.	12 0
1 K.W. 220-230 v. (Two elements used in series)	14 0
500 W. 220-230 v.	12 0

Carriage 2/- extra per heater.

Sketches and details of suitable cabinet are supplied with each heater. 2 K.W. 110 v. heating units are also available at 7/6 each. These are ideal working in series for greenhouse heating, etc., or for space heating under benches, etc. Eight of these in series will consume 1 K.W. and will spread the heat out over a wide area.

EX-GOVERNMENT ODDMENTS

Offers invited for the following :—

TEST SETS. Test Line Balancing No. 2, WBO 2510. R.T. Tester No. 6. Test Set 72. Test Set 209 with indicator unit type 176. Test Set 70, Test Set 76. Calibrator Unit 115.

TRANSMITTER RECEIVERS. T.R. 5043, T.R. 1133.

TRANSMITTERS. T.3040, T.1366.

RECEIVER UNITS. ASB4; RU19; Type 159; No. 9 Mark 1; R103; R147; BC639A; R3515; R3547; 38 Mark 2; 1132A; AAPN4; R1545; 3085; 3206; 1626; 3540; 3120.

INDICATOR UNITS. Type 6C; Type 62; Type 62A; Type 48A; Type 94; Type 96; Type 97; Type 184A; ASB/4.

MIXER UNIT. W6331. **RESPONSER UNIT** APW4790.

STROBE UNITS. Types 68 and 61.

BOOKS AND PUBLICATIONS

"DEMOBBED VALVES." Gives the commercial equivalents of many thousands of service valves, and conversely gives the service equivalent of many thousands of commercial type valves, an invaluable publication recently revised. Price 2/3. **"AN ELECTRONIC TIMER."** Shows how to build a device for controlling timed operations. The timer can be set to any timing up to 3 minutes. Price 2/3. **"THE ELECTRONIC SWITCH."** Shows how to make a device for switching without mechanical contact. Price 2/3. **"THE IMPULSE RELAY."** Explains the working of an ingenious relay, and gives several circuits including radio control. Price 1/9. **"3½-WATT CONVERTIBLE AMPLIFIER."** Shows how to construct a 3-stage amplifier with an output of 3½ watts, a unique feature is that this amplifier fits into our "Occasional" cabinet. Price 1/6. **"THE I.F. A.F. AMPLIFIER."** Gives details of a 465 kc/s. amplifier with A.V.C. detector and power output stage. Designed to fit into our "Occasional" cabinet, it is useful for aligning coil packs and for use as a signal tracer in radio servicing, etc. Price 1/6. **"THE OCCASIONAL T.R.F."** Shows how to build a T.R.F. Receiver for medium and long wave reception, of looks and quality output comparable with sets priced between £10 and £14. This costs less than £6 to build including cabinet. Price 1/6. **"THE 'OCCASIONAL SUPERHET.'"** In areas where field strength is low and interference is high, a superhet receiver is essential. For less than £8 one can be built into our "Occasional" cabinet. This publication gives all details. Price 1/6. **"VALVE EQUIVALENTS."** These are the best equivalents charts available today. Also the booklet can be used for keeping records of valve stocks. Price 2/6. **"I.F. ALIGNMENT PEAKS."** This book gives the I.F. frequencies of more than 4,700 receivers, British, American and Continental. A very popular British set is covered, and hints on finding the frequencies of unknown British sets are also given. Price 4/6. **MAKING COIL PACKS.** Shows how standard type coil packs can be made and aligned at very low cost. 1/6. **VISUAL ALIGNMENT SIGNAL GENERATOR.** Reprint from "Radio Constructor" describes a very useful combined signal generator and oscilloscope. 9d. **T.V. FROM RDF1.** Reprint of the articles which recently appeared in "Practical Television." 1/3 post free.

STOP PRESS

5 WAVEBAND 7 VALVE RADIO CHASSIS

A famous set by a famous manufacturer. Undoubtedly a serious listener's receiver. It has H.F. stage, tuning indicator and tunes up to 11 metre band. Price, new with all valves but less speaker, **£14/19/6**, carriage and packing case, 10/- (partly returnable). A.C. mains and car battery models available.

ELECTRICAL INSTALLATION MATERIALS

In addition to our large range of radio accessories we also carry a good stock of electrical wiring accessories, details of a few of these and of cables can be found below :—

T.R.S. CABLES, 250 v. CLASS

3/.029 twin flat	1/4	yd.
3/.029 3-core flat	2/-	,,
3/.029 twin, with earth	1/8	,,
7/.036 twin flat	2/9	,,
7/.029 twin flat	2/-	,,
3/.036 3-core flat	2/8	,,
7/.029 twin with earth	2/4	,,
7/.064 twin flat	4/9	,,

LEAD COVERED CABLES 250 v. CLASS

3/.029 3-core	2/3	yd.
3/.036 3-core	3/8	,,
7/.044 twin	3/3	,,
3/.036 twin	2/-	,,
7/.099 twin	2/9	,,
7/.064 twin	5/-	,,

WAR EMERGENCY TYPE CABLES 250 v. CLASS

These are P.V.C. or rubber insulated, laid flat then braided with cotton and compounded :

7/.029 3-core flat	2/-	yd.
7/.044 twin flat	2/-	,,
7/.064 twin flat	3/3	,,

MULTICORED FLEXIBLES

All are suitable for mains work as the separate conductors are very well insulated, then they are covered overall either with hard rubber, plastic or waterproofed braiding :—

10 core	2/6	yd.
7 core	2/-	,,
5 core	1/-	,,

FUSE BOARD

Iron clad with conduit entry knockouts. 3 way, 15 amp. (6 fuses) Price 15/- each.
Other fuse boards in stock (wood and iron cased) up to 12 way.

LAMP HOLDERS

Bakelite type threaded for ⅜in. with HO skirt 1/6.
Bakelite type threaded for ⅜in. with HO skirt 2/-.
Bakelite type threaded for ⅜in. with switch and HO skirt 3/6.

EDISON SCREW. Cord grip, porcelain 4/6.

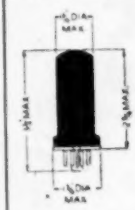
WELL GLASS FITTING with porcelain BC lamp holder threaded for ⅜in. less glass 10/-.

TUMBLER SWITCH. 15 amp. with polished brass cover 1/6.

DOOR SWITCH. Single pole Crabtree 5 amp flush type switch in iron box with plunger, suitable for controlling lighting of telephone booth, etc. 4/6.

M.E.M. SWITCH FUSES. All insulated, double pole 250 v. 10 amp. 6/- each.

WATERTIGHT SWITCH. Iron clad ⅜in. conduit entry 7/6 each.



GUESS WHAT FOR £5

The item illustrated in our November "Guess What" Competition was a Bolometer 14MW, 10E756. Prizes were sent to the readers whose solutions were the first three correct ones opened. The names of the winners were sent to all entrants. This month's "Guess What" is definitely a matter of luck as it can be any one of several valves but three people will be lucky so don't forget to send your "Guess" when next writing to us. We offer prizes of £5 to the first, £3 to the second and £2 to the third correct answers opened.
Closing day for entry first post January 26th.

ELECTRIC HEATERS

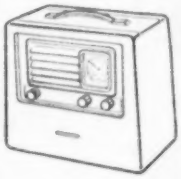
Heavy cast framework totally encloses the elements, so these are 100 per cent. safe even in confined spaces, just right for your radio den, garage, office, shop, etc. 750 watt model, 23/6, plus 5/6 carriage. Other model available, 500 watt, price 23/6 each, plus 5/6 each carriage.

EQUIP YOUR LAB. FREE GIFT FOR YOU

Are you proud of your stock of resistors? Many of us Radio engineers (and the writer was no exception) start off with good intentions, but end up with resistors all mixed up in a box, so that we never really know what's in stock, and often spend a long time fiddling through to find one near enough for what we want.
Realising this problem one of our go-ahead manufacturers decided to sell resistors packed in such a manner that they can be stored in a hardboard cabinet like filing cards, an extra novel feature being that the card is corrugated so that resistor sits in the groove, and unlike the usual method of mounting on cards the wires do not have to pass through holes, but are kept perfectly straight. To remove you simply slide the resistor along and withdraw it. In a similar way and with the same ease it can be replaced. You have only to look through the cards to see when you are getting low, and you simply order another card of that particular value. It is undoubtedly an excellent idea which will find universal use as it becomes well known. You can have this unique system in use in your Lab. or workshop without any trouble, and at no cost other than that of the resistors. The cabinet is free.
The cabinet complete with 432 small carbon type, ½ watt resistors, 36 standard valves ranging from 10 ohms to 6.8 Megohms, Price £10 carriage free.

ALL OF US AT FLEET STREET AND RUISLIP
WISH YOU A HAPPY AND PROSPEROUS NEW YEAR

MAINS/BATTERY PORTABLE



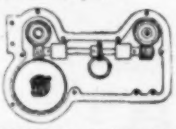
Ultra modern cabinet, highly suitable for making up an all-mains and/or all-dry battery receiver. Cabinet dimensions, 7¼in. deep and 10¼in. high × 12in. wide. Imitation crocodile cabinet with back and wooden platform, battery dividers, inner front drilled for three controls, and handle, 22/6 complete.
Ivory Fret with Perspex Window, loud speaker louvres and turning scale, 5/6.
Frame Aerial wired for long and medium wave with plug board and tag strip, 5/6. Unwired, 2/6.
Metal Chassis punched out and with loudspeaker cut out, 5/6.
Assembly for holding dial and lamps, 1/9.
Matched Knobs, set of 3, 2/-.
Or all items unwired frame aerial, 38/6; wired frame aerial, 42/6.

Circuit diagram of suitable receiver free with cabinet.

Orders by post are dealt with by our Ruislip depot. To avoid delay address to :— E.P.E. Ltd., Dept. 2, Windmill Hill, Ruislip, Mddx.

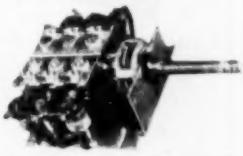
I.F. TRANSFORMERS

465 kc/s iron dust cores fitted in aluminium can size 1¼in. × 1¼in. × 3¼in. Price 12/6 pair.
Midget type, 465 kc/s size 1¼in. × 1¼in. × ⅞in. (M400B). Price 17/6 pair. 465 kc/s. ex-equipment in good condition fitted in standard size can, dust cored. Price 7/6 pair.



REDUCTION GEAR BOX

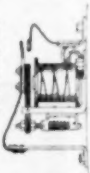
Totally enclosed in aluminium housing. Size 5¼in. × 3¼in. × 1¼in. Three speeds obtainable. A real bargain with 101 uses in any workshop. Price only 8/6 plus 9d. postage.



'ELPREQ' 3 WAVE BAND COIL PACK

This is a really first class pack for long medium and short waves with iron dust cored coils. IF 465 kc/s. Size 3in. × 2¼in. × 1¼in. Guaranteed pack complete with circuit diagram. Price 29/6.

RELAYS



Contactor for breaking 25 amps., coil voltage is 24 v. D.C., but with a re-wind or a small rectifier these will close off A.C. mains. Very heavy duty solid silver contacts. Price 3/6.

Totally enclosed in bakelite, this relay has a 24 v. coil but can of course be re-wound for mains operation. Its contacts are suitable for breaking 20 amps. Price 4/6, 48/- doz.

TWO-GANG 75 pFd. TRIMMER

We have an excellent selection of trimmers, air spaced, and mica/compression type. The one illustrated is more than a trimmer, as it can be used to tune many short-wave circuits, it is actually a two-gang, 75 pFd. air-spaced variable condenser. The spindle length is approximately ¼in. Price 4/9 each.

Orders under £2 add 2/6, under £1 add 1/9. Postable items can be sent C.O.D., additional charge approx. 2/6. List 4d.
Early closing days: Wednesday Ruislip Saturday, City.

ELECTRONIC PRECISION EQUIPMENT

WINDMILL HILL, RUISLIP, MDX. Phone: RUISLIP 5780
152-153 FLEET STREET, E.C.4. Phone: CENTRAL 2833

You're SURE to get it at

STERN'S

ESTABLISHED 25 YEARS

BUILD A PROFESSIONAL RADIO OR AMPLIFIER AT LESS THAN HALF TODAY'S PRICE

ALL KITS INCLUDE "EASY TO FOLLOW" POINT-TO-POINT WIRING DIAGRAMS

A MAINS OR BATTERY PORTABLE KIT

A Midget 4-valve Superhet Portable Set covering medium and long wavebands.
Designed to operate on A.C. mains 200-250 volts, or by an "Alldry" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied (a) as an "Alldry" Battery Superhet Personal Set, which can then be accommodated in the Attache Case as illustrated above (size 9½in. × 4½in. × 7½in.). This is attractively finished in Dark Green or Blue Rexine (b) or as a Combined Mains/Battery Superhet Portable Receiver, for which a polished Wood Cabinet is available to accommodate both Mains Unit and Batteries together.
Circuit incorporates delayed A.V.C. and Pre-selective Audio Feedback. Kit is complete in every detail and includes ready wound frame aerials, fully aligned I.F. Transfs. and drilled chassis, etc. Overall size of assembled chassis 8in. × 6in. × 9½in.
We can supply the set either as a complete Kit of Parts for **£8.16.9** (incl. P.T.) (plus Cabinet and Mains Unit), or by supplying the components separately. The complete Assembly Instructions, which include full price details (including prices of individual components), Circuit and Component Layout etc., are available for **1.9** (incl. postage).

A T.R.F. BATTERY "PERSONAL" KIT

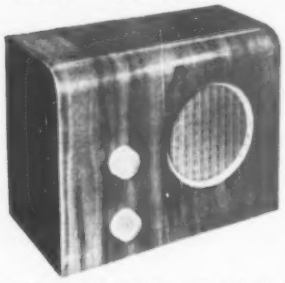
A complete Kit of Parts to build a Midget 4-valve Alldry Battery Portable Set, covering medium wavebands.
Consists of Regenerative T.R.F. circuit, employing Flat Tuned Frame Aerial with Denco Iron Dust Cored Coil. Valve line up, two L.T.4's (R.F. Ampl. and Det.), 185 and 384 output.
Kit is complete in every respect and includes drilled chassis and latest type Rola 5in. P.M. speaker. Overall size of assembled chassis 4½in. × 7½in. × 9½in.
We can supply the Complete Kit (less cabinet) for **£6.4.8** (inc. P.T.) or by supplying the components separately. The Complete Assembly Instructions, including individual component prices, Circuit and Component Layout, etc., is available for **1.-**, incl. post.

A KIT OF PARTS

Complete in every detail, to build a **3-valve Amplifier** for A.C./D.C. mains 200-250 volts.
Has an output of 3 watts, and incorporates a Tone Control.
Valve line up, 12A8, 6J7, U31.
Our price of **£4.12.6** for complete kit includes a matched 6½in. P.M. speaker.
This Amplifier can also be supplied assembled and ready for use for **£5.12.6**.

A MIDGET 4-STATION "PRE-SET" RECEIVER

A complete Kit to build a 4-Station "Pre-Set" Superhet Receiver for A.C. mains operation.
The set is designed to receive any three stations on medium wavebands and one on long waves, each station being received by the turn of a Rotary Switch—No Tuning being necessary.
It is of midget size, being 8½in. × 4½in. × 7in. high, and has the performance of a far more expensive ready-made set, but can be built for half the price.



Price of complete Kit of Parts (including aligned I.F. Transf. and drilled chassis, etc.), **£9.2.6** (incl. P.T.) (plus Cabinet **£5.6**), or the components can be purchased separately. The complete Assembly Instructions, including Individual Component Price List, Circuit and Component Layout, etc., is available for **1.9**.

STERNS "RADIO TUNER MANUAL," Price 2.6.
(Plus 3d. Post). Contains complete and detailed assembly instructions showing how to make :—
A **1 Valve T.R.F. Tuning Unit**, covering Long and Medium Wavebands.
A **4-Station "Pre-Set" Superhet Tuning Unit**, producing 2 Stations on Medium Waveband and 1 on Long Waves.
A **2-Valve Superhet Tuning Unit**, covering Short, Medium and Long Wavebands.
Each Tuner is for A.C. Mains operation. Circuit Diagrams and Practical Component Layouts are shown, together with complete component Price Lists.

THE WIRELESS WORLD MIDGET A.C. MAINS 2-VALVE RECEIVER

We can supply all the components to build this set, including Valves and Moving Coil Speaker for **£3.10.-**, including Designer's complete building instructions (these are available separately for **9d.**).

THE "SUMMER ALLDRY" BATTERY PORTABLE

As published in June issue of "Practical Wireless." We can supply from stock, all the components to build this Midget 3-valve Portable for **£3.2.0** (less valves). This also includes dials, top panel and alu. sheet for chassis. The complete article and circuit, including Practical Layout and Price List, is available for **9d.**

PICK-UPS

Cosmocord "G.P.20," for standard records, **£3.11.5**; interchangeable (G.P.19) Head for L.P. records, **£2.3.4**.
Decca lightweight "turnover Head" type, for L.P. and standard records, **£3.19.2**.
Marconi, Standard, lightweight Magnetic, **£1.15.10**. Marconi Matching Transformer, **7.6**.
Goldring, Standard, lightweight, Magnetic, **29.6**.

THE WIRELESS WORLD 3-VALVE SET

A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands.
We are able to supply all of the components to build this set, as designed, and specified in the Feb. 1950 issue, including the drilled chassis, valves and moving coil speaker, etc., at the following prices:—
To construct complete chassis, less dial and drive assembly, **£4.17.9**. Ditto, including dial and drive assembly, **£5.12.9**.
To construct the complete Set, including dial and drive assembly and cabinet, **£6.14.3**.
Overall size of cabinet is 7½in. × 5½in. × 11½in.
A reprint of the designer's article, giving Circuit and Assembly Instructions, this is available separately for **9d.**; together with a Practical Component Layout is included with each of above assemblies.

BATTERY CHARGER KITS

All Kits incorporate Metal Rectifiers, and are for use on A.C. mains 220-250 volts. All Kits include an easily followed Wiring Diagram.
For charging 6 v. battery at 1½ amps., **£1.3.9**.
For charging 6 volt battery at 4 amps., with Variable Resistor and Meter, **£2.4.3**.
For charging 12-volt battery at 1½ amps., **£1.6.9**.
For charging 12-volt battery at 4 amps., with Variable Resistor and Meter, **£2.7.6**.
For charging 6 or 12 volt battery at 3 amps., **£1.19.0**.
For charging 6 or 12 volt battery at 3 amps., with Variable Resistor and Meter, **£3.1.6**.

THE WIRELESS WORLD MODERN CRYSTAL SET

Designed for the Pre-selection of THREE STATIONS to suit local conditions, each station being received by the turn of a rotary switch. We are able to supply all components, including drilled chassis to build this new type of Receiver, to the designer's specification, as published in October issue, for **47.4** (including cost of selected coils).
A reprint of the designer's article (available separately for **9d.**), together with a practical component layout, make the assembly very easy.

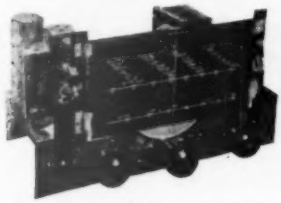
★ *Send 6d. P.O. for our STOCK LIST, it shows "hundreds" of Wireless Bargains*

When ordering please include

STERN RADIO LTD., 109

Tel. : CENtral

AN A.C. MAINS "ALL-WAVE 8-PERHET" CHASSIS



A completely assembled chassis for A.C. mains 200-250 volts, designed for good selective and quality reproduction, and serves as an ideal replacement chassis for that "old radiogram etc.

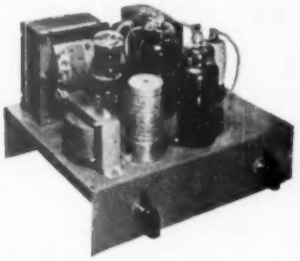
It incorporates in addition to the three controls shown above a Tone Control and a Radio-Gram Switch. These two are left on "flexible leads" to enable them to be placed in any position on cabinet.

The set employs a modern 8-valve line up, and covers three wavebands, 16-50, 187-550 and 800-2,000 metres. Flywheel tuning is incorporated.

Overall size of assembled chassis, 13½in. × 6in. × 8½in. high. Dial size 9in. × 4½in.; an attractive Dial Escutcheon Plate is supplied.

Price of complete chassis, wired and ready for use, **£14 19 6**.

A QUALITY "PUSH-PULL" AMPLIFIER KIT



A Kit of Parts to build a 6-8-watt Push-Pull Amplifier for operation on A.C. mains 200-250 volts.

Incorporates a simple arrangement to enable either a magnetic, crystal, or lightweight pick-up to be used.

A 10-watt Output Transformer is designed to match from 2 to 15 ohm speakers. Tone control is incorporated.

The overall size of the assembled chassis is 10in. × 8in. × 7½in. high. Price of kit complete in every detail, including drilled chassis and valves, **£6 5 -**. Component layout is supplied.

Price of assembled chassis, supplied ready for use, **£7 10 -**.

"PERSONAL SET" BATTERY ELIMINATOR

A complete kit of parts to build a Midget "All-dry" Battery Eliminator giving approx. 90 volts and 1.4 volts.

This Eliminator is for use on A.C. mains and is suitable for any 1-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to 60 volts.

The kit is quite easily and quickly assembled and is housed in a light aluminium case, size 4½in. × 4½in. × 3½in. Price of complete kit, with easy to follow assembly instructions, **42 6**.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 Volts and 1.4 Volts. Size of assembled Unit 7in. × 2½in. × 1½in. Price **47 6**.

You're SURE to get it at

STERN'S

ESTABLISHED 25 YEARS

TWO NEW DENCO ULTRA MIDGET SUPERHET COIL TURRETS

Both having a Rotary Turret Action

(a) The C.T.9 Turret consists of 4 STATION "PRE SET" UNIT, from which any three Stations on Medium Waveband and one on Long Waves can be received by a turn of the Turret Switch.

(b) The C.T.10 Turret being a 3 Waveband Coil Pack, incorporating a fourth switch position providing for completely switching out Radio when using gram. The complete coverage is: Long Waveband 700 to 2,000 metres; Medium Waves 190 to 570 Metres and Short Waves 16 to 50 Metres.

The outstanding advantages these units have over other similar units can be readily seen, the main features being:

(a) Neat and Compact, the overall size being only 2½in. dia. × 1¾in. deep.

(b) Fitting is simplicity itself, each Turret having one hole fixing and requiring only four connections.

(c) The Rotary Turret design switches the actual Coils, which is incorporate variable iron dust cores, on to positive contacts thereby reducing stray capacities to the absolute minimum.

(d) They are supplied Factory wired and aligned and have been designed to operate with any conventional circuit arrangement of 465 K.c.s. and due to their unique design are extremely sensitive and efficient.

Price: C.T.9 Turret **39 6**. C.T.10 Turret, **52 -**.

A complete Receiver circuit together with leaflet containing all necessary data is included with each Turret. These can be supplied separately for **6d**.

THE FAMOUS W.B. "STENTORIAN" RANGE OF P.M. SPEAKERS.

Size.	Impedance.	Watts.	Price
2½in.	2-3 ohms	1	18 6
3½in.	"	2	19 6
5in.	"	2½	21 -
6in.	"	3	24 6
7in.	"	3½	25 6
8in.	"	5	32 6
9in.	"	7	36 9
10in.	"	10	44 6
12in.	"	15	79

New Mrs. Sorpio Speakers. All 2½ ohms. 2½in. **15 -**; 3½in. **14 6**; 5in. **14 6**; 6½in. **16 9**; 8in. **18 -**; 10in. **25 -**; New Tyne Reds, 3in. **21 -**, 4in. **22 6**.

Output Trans. Midget 60-1 (or 50-1) 1in. × 1in. - 1¼in. **3 9**. 5-watt Midget 2-1 or 3-1 ratio. 12 tappings between 7½-1 and 174-1 (some C.T.) **8 6**. Wharfedale 12-watt push-pull multi-ratio **25 -**. P.P. pull 20-watt multi-ratio **7 6**, and many others.

Ext. Speaker Volume Control, **2 6**.

New Electrolytic Condensers. Not Ex-Govt. All 450/500 volts. 8 mfd. (1¼in. × ½in. dia.), 3 -; 8-8 mfd. (1¼in. × 1¾in.) **4 9**; 16-8 mfd. (1¼in. × 1in. dia.) **5 6**; 16-16 mfd. (1¼in. × 1¾in. dia.), **5 9**; 32 mfd. (1¼in. × 1¼in. dia.), **5 9**; 32-32 mfd. 500 volt **5 9**; Carribonit Tubular, 4 mfd. 500 v. **2 6**; 8 mfd. 500 v. **4 -**; 16 mfd. 500 v., **5 9**. Can. Standard size all 500 volts. 4 mfd. **3 6**; 8 mfd. **4 3**; 8-8 mfd. **5 9**; 16 mfd. **5 6**; 16-16 mfd., **7 9**; 32 mfd. **6 9**.

Denco I.F. Liner, for accurately lining 465 K.c. and 1.6 m.c. I.F. channels, and associate circuits. Battery operated small and completely self-contained, **47 6**.

Potentiometers. New, not Ex-Govt. 5K, 5K, 10K, 25K, 50K, 100K, 250K, 1, 1 and 2 meg. Price, less switch, **3 9**. Price with S Pole switch **5 9**. Price with D Pole switch **6 6**.

Sorpio Potentiometers. All standard with extended spindles. 5K, 10K, 15K, 20K, 25K, 50K, 100K, ¼, ½ and 1 meg., **2 -** each.

Coils. Denco "Maxi Q," midget size, Litz wound on Polystyrene Formers, with adjustable iron cores. Available for Aerial, H.F. and Oscillator 465 K.c., or 1.6 M.c., **3 9** each, or with reaction winding, **4 9**. Denco Midget Superhet R.F. Coils for long and medium waves, **6 6** per pair. Wavemouth matched pairs of coils for T.R.F. covering long and medium waves, **10 6** pr., or for 8a with 3 covering Long, Medium and Short Waves, **11 6** prs. All types of Wearite "P" coils in stock at **3 6** ea.

Coil Packs. Osmor Midget Coil Pack. Size 3½in. × 2½in. × 1¼in., covering S., M. and L. waves. Coils wound on Polystyrene Formers with adjustable iron cores ensure efficient performance. Factory wired and aligned. Price, including full circuits for Superhet 465 K.c. Unit, **52 -** (incl. P.T.). This Osmor Coil Pack is also available for Midget Superhet BATTERY Portable 4 Cir. including a matched ready wound Frame Aerial. Price **54 2** incl. P.T.). **Wavmouth** Midget 3½ × 2½ × 1¼in. covering S.M.L. waveb. for 465 K.c.s. employing Matched Iron Cored Coils on each waveband, **51 6**.

Wearite Pack, 4½ × 3½ × 1¼in. Type 706, covers two short wavebands and medium waveband and Type 703 covers short-medium-long waves. Both for 465 K.c.s. Incorporate gram position, and employs adjustable cored coils, **53 4**.

All of the above Coil Packs include Switching, Padding and Trimmer Condensers.

L.F. Chokes. Midget 10 henry 250 ohms 40 mA., **4 6**; 20 hy. 250 ohm 60 m.A., **6 6**; 20 hy. 300 ohm, 100 mA., **12 9**; 8 hy. 90 ohm 250 mA., **28 6**; 20 hy. 750 ohm 120 mA., **15 6**; 9 hy. 250 ohm 120 mA., **8 6**; 18 hy 200 ohm, 2-0 mA., **26 6**.

I.F. Transformer, 465 K.c. New well-known manufacturer's surplus 2in. × 2½in. × 4in. Iron Core, **9 -** each. Denco Iron Core, 465 K.c. or 1.6 m.c., 1¼in. × 1¼in. × 3¼in. **16 6** pair. Wearite Stand Cap, Tuned 465 K.c., **20 -** pr. New Surplus 465 K.c. Iron Core, tin. × 1¼in. sq., **10 -** pr.

Transformers. (a) Input 230 volt, output 200 volt 25 m.a., 6.3 v. 3 amp., **11 -**; (b) Input 230 volts, output 250 volts 30 m.a., and 6.3 volts 1 amp., **13 9**.

H.T. Transformer. Prim. 230 v. Sec. 3 Kv. and 4-volt tapped 2 volt, **59 6**. Ins. but 4 Kv., **84 -**.

Heat & Auto Transformers. (a) tapped 2 v. 4 v. 5 v. and 6.3 volts 3 amp., **9 6**; (b) 4 v. 3 amp. to 5 v. 2 amp. Reversible, **6 6**; (c) 4 v. 3 amp. to 6.3 v. 2 amp. Reversible, **6 6**.

NEW SURPLUS!! FOSTER TRANSFORMERS. Primary 230 volts. Secondary 17 volts 9 amps., **31 -**.

Filament Transformer. Input 230 volts, outputs 6.3 v. 1½ amp., **8 3**; 4 v. 1½ amp., **7 6**; Input 200/250 v. output 4 v. (C.T.), 1½ amp., 4 v. 2 amp., 6.3 v. 2 amp., **19 6**. Input 230 v., output 6.3 v. (C.T.) 4 amp., **17 6**.

Metal Chassis substantially made with four sides. 3in. × 4in. × 1in., **3 11**; 9 × 5 × 2½in., **5 3**; 10 × 6 × 2½in., **6 -**; 10 × 7 × 2½in., **6 3**; 12 × 8 × 2½in., **7 9**; 14 × 9 × 2½in., **8 3**; 16 × 8 × 2½in., **9 -**.

Ratio Transformers. All New Stock with Primaries tapped for 200-250 volts. Secondaries (a) 250-0-250 volt, 80 mA., 6.3 v. (tapped 4 v.) 4 amp. and 5 v. (tapped 4 v.) 2 amp., **18 6** (also available with 350-0-350 volt at **18 9**. Stern's 350-0-350 volt, 150 mA., 6.3 v. (tapped 4 v.), 4 amp. and 5 v. (tapped 4 v.) 2 amp., **41 6**; (c) 350-0-350 v. 200 mA., 4 volt 8 amp., 4 v. 3 amp., 6.3 v. (tapped 2 v.) 2 amp. and 6.3 v. 6 amp., **84 -**, and many other ratings.

Westinghouse Rectifiers. (a) H.T. 51. Rated 350-0-350 volt 100 mA., **35 -**; (b) H.T.52. Rated 350-0-350 v. 200 mA., **37 6**; (c) H.T.53. Rated 500-0-500 v., 200 mA., **50 -**.

Types. 14D6, **11 3**; 16HT28, **12 6**; 16EHT36, **17 9**; 36HT25, **13 10**; 36KH Cla, **15 2**; 36KH (40), **20 6**; 36HT45, **22 6**; 36EHT30, **24 10**; 36KH99, **25 -**; 36KHT100, **28 -**; 36KHT13, **7 9**.

F Wave Bridge Rectifiers:

For charging 2, 4 or 6 volt at 1½ amps.	**8 6**
For charging 6 or 12 volt at 1½ amps.	**12 9**
For charging 6 or 12 volts at 3 amps.	**21 6**
For charging 6 or 12 volts at 5 amps.	**28 10**
For charging 12 or 24 volts at 3 amps.	**35 9**

A Variable Resistor for control of Charging Equipment for Model (a) up to 3 amps., **15 -**.

Suitable Charger Meter, man. 4 amps., **7 6**.

Meter Rectifiers. Westinghouse 150 micro amp., **12 9**; 1 mA., **11 9**; 5 mA., **6 9**.

Bellmain Rectifier. H.T. H. wave, 250 v. 50 mA., **5 6**; 250 v. 100 mA., **7 6**, 250 v. 170 mA., **13 9**.

Charger Transformers. Suitable for use with preceding Rectifier. Each has input of 230 volts. Outputs: (a) 24 volts tapped 1a v. 9 v. and 4 v. at 3 amps., **25 6**; (b) 30 volts tapped 15 v. and 9 v. at 3 amps., **26 3**; (c) 15 volts tapped 9 v. at 3 amps., **19 6**; (d) 12 volts 14 amps., **12 3**; (e) 15 volts tapped 9 v. at 6 amps., **24 3**; 15 volts tapped 9 v. at 1½ amps., **15 3**; 12 volts 1 amp., **7 6**.

A Battery Charger Wiring Diagram is included with purchase of Charger Transformer and Rectifier.

Adjustable Mains Droppers. 1¼in. dia. × 2½in. (a) 15 amp. 1.5 ohms, **5 -**; (b) .2 amp. 1,000 ohms **4 3**; (c) .5 amp. 600 ohms, **5 -**.

Television. We keep a very comprehensive range of T.V. components. The Viewmaster T.V. Assembly Instructions showing Practical Layout and Price List in stock, price **5 6** (incl. post). We can supply all the specified components for the T.V. ex stock either by way of individual purchase or by the published stages.

"G" Max Chassis Cutters. The quickest and most simple method of Chassis cutting consists of a die, punch and Allom screw.

To cut ¼in. dia. (B7G)	**10 6**
To cut ⅜in. dia. (B8a)	**10 6**
To cut 1¼in. dia. (Octal)	**13 6**
To cut 1¼in. dia. (English)	**13 6**
To cut 1¾in. dia. (EF.50)	**14 6**
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Adjustable **Chassis Cutter** for holes from ½in. to 2¼in. dia. (used with hand brace), **7 6**.

The "Handy-Utility" ¼in. Portable Electric Drill for use on A.C. or D.C. mains. A powerful and robust drill that will drill wood, metal and almost anything, can also be used for grinding, buffing and wire brushing, etc. Employs instant release trigger switch. Price **£6 10 -**. Descriptive leaflet is available.

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Components and many KITS OF PARTS for both Sets and Battery Chargers.
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ESTABLISHED 25 YEARS

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PLEASE SEND, BRING OR PHONE FOR OFFER

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THESE ITEMS ARE ONLY A SMALL SELECTION FROM OUR STOCK OF EQUIPMENT. YOUR ENQUIRIES FOR ANYTHING THAT YOU MAY NEED WILL BE WELCOME. WE HAVE OTHER EQUIPMENT ARRIVING DAILY!

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For 12in. cathode ray tubes. Beautiful figured medium walnut finish, with high polish. Fitted with shelf for receiver, glass, speaker baffle and fret, and castors for easy movement. Undrilled. Suitable for use with the Viewmaster, "Practical Television," "Practical Wireless," and "Wireless World" televisors.

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Outside dimensions of cabinet: 17½in. x 16½in. x 32in.

Why not convert your table receiver to a console?

Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.

W.B. & PLESSEY T.V. COMPONENTS.

Tube Supports	16/-
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Comprises 12in. cathode ray tube (by either Brimar, Mullard or Mazda), Boost EHT Kit, 12in. mask and armour plate glass. Inductance width control.

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BOOST E.H.T. KIT. Comprises one selinium rectifier, one 2-meg. resistance and two T.C.C. .001 mfd. 6 kV. condensers. For converting 9in. T.V. receivers to 12in.
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Standard impedance.
Single screened, 1½d. per yard.
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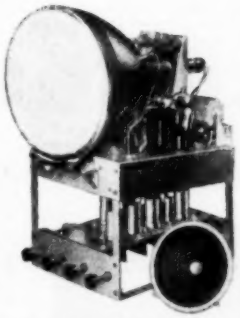

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.001 mfd. 6 kV. Price 4/6 each.
.001 mfd. 12.5 kV. Price 7/6 each.
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ENGRAVED KNOBS. 1¼in. diameter. ¼in. Spindle. For television, radio and amplifiers. All types. (Brilliance, tone, etc.).
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TELEVISION VALVES. MOSTLY AT PRE-BUDGET PRICES. EL38, EL33, 6P28, 6K25, EY51, 62BT, 7C5,PL38,PZ30,GZ32, Etc.
NO SHORTAGE AT LASKY'S.

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9in., with fitted armour plate glass	10/6
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Brand new white	19/6
Special for flat face tubes	22/-

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ARMOUR PLATE SAFETY GLASS. For 9in. tubes 3/11, 12in. 4/11 per piece. Post 1/- each.

TINTED SCREEN FILTER PLATES. 9in.-10in., 18/6 12in., 25/-. Postage 1/- each extra.

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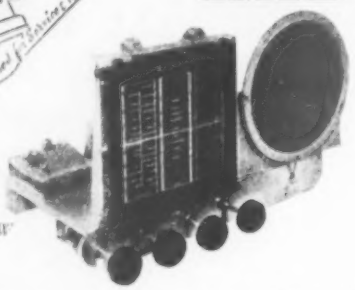

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Chassis, complete with all Valves and Speaker.
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Chassis, less all valves and speaker.
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★ 5 new valves. ★ 8in. Elac. p.m. speaker. ★ Variable tone control. ★ 4 watt output.
★ Large edgelit dial, 7½in. square. ★ 2-speed tuning with nylon drive. ★ 465 Kc/s I.F.
★ Sockets for p.u. and extension speaker. ★ A.V.C. ★ Circuit diagrams.
Size of chassis: 15½in. wide, 8in. deep, 2½in. high.

Plastic Cabinet. Size 19" wide, 10" deep, 12½" high.
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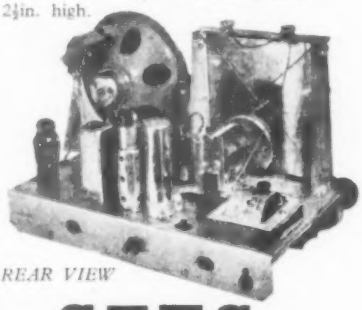
NOT A KIT, BUT A FACTORY BUILT JOB.
FULLY ALIGNED AND TESTED.

Write for full details.
Circuit diagrams supplied for 1/6.
Highest Quality Components.



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MANUFACTURER'S SURPLUS.
Uses 3 valves: 25Z4, 25L6 and 6J7. For 6 station operation. AC/DC mains input.

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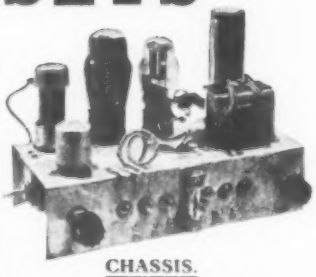

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Less valves and bulbs.
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Permeability tuned. 440-520 Kc/s. Type 551. Critically coupled, with top grid connection. Type 552. Closer coupling for feeding diode circuit. Q115. Inductance 700 microhenries, at 465 Kc/s.
Band width of each of the above transformers is 7-20 Kc/s at 3-20 Dbs. Size :—3½in. high. 1¾in. square. Supplied with fixing screws and nuts.

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ALL YOUR RADIO VALVE REQUIREMENTS AT LASKY'S

CARBON POT METERS

All with long spindle, ¼, ½, 1 and 2 meg.
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With switch 4 3 each.
All post extra.
Short Spindle and pre-set. PRICE 1 6 each. Post extra.

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20 M/a. 40 H.	3 11
40 M/a. 8 H.	3 11
40 M/a. 10 H.	4 3
75 M/a. 150 H.	8 6
80 M/a. 10-20 H.	4 11
120 M/a. 10-20 H.	7 6
150 M/a. 10-20 H.	10 6
250 M/a. 10-20 H.	15 6
150 M/a. 2 H.	3 6
250 M/a. 3 H.	10 6

Postage extra.

EXPANDED METAL SPEAKER FRET

Metal, one side finished gold, other side silver. Size: 12in. × 12in.
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BRAND NEW IN MAKER'S ORIGINAL WOOD CASE. Contains 1 cathode ray tube, 6in. VCR517. Also the following valves: three SP61, one 6J5, three KA50, one D1. Dozens of components, coils, resistance, condensers, seven pot. meters, etc. Enclosed in metal case, size 12in. × 9in. × 19in. Weight 40 lb.
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Type RM1. 125 volts at 60 m/a. Price, 3 11. Post 4d.
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Any number can be used together, either in series or parallel.

P.M. LOUDSPEAKERS

New and unused. First quality. All less o/trans.

3in.	12 11	8in.	14 9
5in.	12 6	10in.	22 6
6½in.	13 6	12in.	75 -

Postage extra on each speaker.
ALL THE BEST MAKES AT THE BEST PRICES.

EX-A.M. RECEIVERS TYPE R1481

IN ORIGINAL WOOD CASES. Frequency coverage: 66-88 Mc/s. Description: Contains 11 valves: 1 VR65, 1 VR66, 4 VR53, 2 VR54, 1 6J5, 1 VR70, 1 VR57. Large tuning scale with slow motion drive, 0-5 m/a. tuning meter, R.F. and I.F. gain controls, jack sockets for line and 'phone. Totally enclosed in metal case, grey enamelled, with plated handles. Size 18in. × 10in. × 11in. Weight packed, 54lb. Supplied complete with circuit and calibration chart. Sailed condition.
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Carriage 10/- extra

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The receiver section of the TR1196 equipment. Easily converted to an all-wave receiver 6 valve superhet. Valve line up: two EF36, two EF39, one EK32, one EBC33. Full details and circuits supplied free with each receiver. Slightly soiled but unused.
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Carriage 3 6 extra.
The Receiver 25, less valves.
LASKY'S PRICE 8 6
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EX-GOVERNMENT TEST INSTRUMENTS. PERFECT CONDITION. Evershed and Vignoles, 250 volt bridge meg. tester. In leather carrying case.
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BATTERY CIRCUIT TESTING OHMMETER. By Evershed and Vignoles. In leather carrying case.
LASKY'S PRICE £4 19 6 Carriage extra.

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5 mfd. 500 v.w.	2 6
8 mfd. 450 v.w.	3 -
8 × 8 mfd. 500 v.w.	5 3
12 mfd. 50 v.w.	2 3
16 mfd. 450 v.w.	4 11
16 mfd. 500 v.w.	5 3
16 × 16 mfd. 450 v.w.	5 6
24 mfd. 450 v.w.	6 11
25 mfd. 25 v.w.	1 11
20 × 40 mfd. 350 v.w.	6 11
32 mfd. 450 v.w.	8 11
32 mfd. 500 v.w.	9 9
32 × 32 mfd. 350 v.w.	5 6
50 mfd. 12 v.w.	1 9
50 mfd. 50 v.w.	2 9
50 mfd. 350 v.w.	2 11
50 mfd. 350 v.w. A.C.	17 6
12 × 12 mfd. 350 v.w.	3 11

Postage extra.

EPICYCLIC DRIVES

For ¼in. spindle standard reduction.
LASKY'S PRICE 1 6 each.
Post 4d. extra.

A GENUINE MINIATURE 2-GANG TUNING CONDENSER

.0005 mfd. Size: 1¼in. deep. 1¼in. high. 1in. wide. ¼in. spindle. With trimming post.
LASKY'S PRICE 6 6 each.
Post 6d. extra.

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No. 1. 3 Wavebands. 12-35 metres. 35-100 metres. 200-550 metres. ¼in. spindle. 1½in. long wavechange switch. Completely assembled and wired. Size: 4in. × 4in. × 3in. BRAND NEW.
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Circuit available, price 1 -.

ALL OTHER TYPES AND MAKES OF COIL PACKS AVAILABLE
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Model RC.500. Magnetic pick-up	£11 15 7
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DECCA GRAM MOTORS

Single Speed	£3 14 4
Three Speed	£7 3 4

SETS OF ENGRAVED KNOBS.

1 each: Tuning, Volume, L.M.S.O., and Tone.
LASKY'S PRICE 4 - the set. Post extra.

J.RA.2. 10-12 WATTS CHASSIS AMPLIFIER

Uses an L63 feeding 2 KT61s in push-pull. Rectifier type U50. Size: 9in. × 17in. on 2in. chassis.
LASKY'S PRICE £7 19 6
Carriage and packing 10 - extra.
Send 3d. stamp for further details of J.RA.2 Amplifiers.

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Miniature Pentode (1S4, 3S4)	3 11
Midget Pentode, 40 M/a.	4 3
Multi-Ratio Standard	6 11
Push-Pull, 80 M/a. Ratios of 40 : 1 and 60 : 1	8 6
Push-Pull for PX4's	12 6
80 M/a heavy duty, multi-ratio	12 6
10 Watt multi-ratio	16 11
20 Watt, 70 M/a. Multi-ratio	29 6
Bulgin intervalve transformers. Ratio 4 : 1	3 11
5 : 1	5 11
Standard Pentode 60m/a	3 11

Postage extra.

FILAMENT TRANSFORMERS

All primaries 220 volts 50 c.p.s.

FIL. 2. 6.3 v. 1.5 a.	Price 6 11
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FIL. 4. 7 v. 2 a.	Price 4 11
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Special Transformer. 30 volts at 2 amps. with the following tappings:—3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. Price 19 6
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All 200-250 volts 50 c.p.s. primary. Finest quality, fully guaranteed.

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Postage 1 6 extra per transformer.

AUTO TRANSFORMER. TYPE AT 3

0-10-120-200-230-250 volts. 100 watts.
LASKY'S PRICE 19/6 Postage 1 6.

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Each section is steel heavily copper plated. 12in. long and ¼in. in diameter. Any number of sections can be fitted together. **LASKY'S PRICE 2 6** per doz.; 6/- for 3 doz.; 11/- per half gross; 20/- per gross. Post free.

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1925
"World Renowned for Service & Reliability"

DUAL WAVE COILS

M. & L.T.R.F. AE. and HF.
LASKY'S PRICE 5 11 Per pair
Post 6d. extra.

EX-A.M. COMMUNICATION RECEIVER TYPE R1155

BRAND NEW IN WOOD TRANSIT CASE. Aerial-located before despatch. Supplied complete with 10 valves. Circuit: R.F.G., A.V.C., R.F. Amp., two I.F. stages, magic eye, etc. 5 frequency ranges: 18.5-7.3 Mc/s., 7.3-3.0 Mc/s., 1,500-600 kc/s., 500-200 kc/s., 200-75 kc/s.
LASKY'S PRICE £12 10 -
Carriage (in wood case) 7 6 extra. Full modification data and circuit details supplied.

CRYSTAL DIODES

Wire ends. Supplied with circuit.
LASKY'S PRICE 3 11 each.
Post 3d. extra.

VIBRATOR PACKS

For use with the P.C.R. Philips Communications Receiver. 12-volt input. Supplied complete with vibrator and metal rectifiers, etc.
LASKY'S PRICE 39 6
Carriage 5 - extra.

TABLE MICROPHONE STAND

Two sections chrome plated. Crackle finished base.
LASKY'S PRICE 17 6
Post, packing 2 6 extra.

LASKY'S OWN TEST PRODS

Made for safety.
Fused test prods. Fully insulated pencil type with retractable point. Contact is only made when desired by pressing top. Each prod contains a cartridge type fuse and spring.
LASKY'S PRICE 4 11 per pair (one red, one black). Post 6d. extra.

ROUND NOSED PLIERS. 3 Sizes.
LASKY'S PRICE 1 3 per pair. Post 6d. 3 pairs for 3 9. Post free.

NEW EX-GOVERNMENT. 12" MAGNETIC FOCUS AND DEFLECTION CATHODE RAY TUBES.

Type CV1140 equivalent to VCR140. **FOR CALLERS ONLY.** O.K. for TV. Heater 4v. E.H.T. 4-5kv.
LASKY'S PRICE £5/10/0

CAR BATTERIES

By DELCO-REMY. Ex-American Army. Absolutely perfect, brand new and unused, in maker's original packing.
No. 1. 6-volt 140 A.H. approx. Size: 7in. deep, 13in. wide, 9¾in. high. In genuine hard rubber case.
LASKY'S PRICE £4/19/6
Carriage 7 6 extra.
No. 2. 6-volt 90 A.H. Size: 9in. wide, 7in. deep, 9in. high. In genuine hard rubber case.
LASKY'S PRICE 87/6
Carriage 7 6 extra.

MAINS DROPPERS

All types from 2 6 each. 12 assorted 25 - Post free.

MIDGET YAXLEY SWITCHES

4 pole 2 way. Long spindle.
LASKY'S PRICE 2 11 Postage 3d. extra.

LARGE STOCKS OF RESISTANCES ALWAYS AVAILABLE

All values. Prices :—1/10th and 1/8th watt, 7½d. each; 1 and ½ watt, 4d. each; 1 watt, 6d. each. Postage extra.

MONEY BACK GUARANTEE

Everything ordered from Lasky's is guaranteed to be as advertised. If you are not more than satisfied return goods for cash refund.

PREMIER RADIO Company

RADIO — R. H. MORRIS & CO. (RADIO) LTD — TELEVISION

BRAND NEW R1155 RECEIVERS
In original cases, complete with 10 valves, £12 10 -. 7/6 packing and carriage.

BRAND NEW R1355 RECEIVERS
In original cases, as specified for the "Inexpensive Television," complete with 11 valves, £2 15 -, 7/6 packing and carriage.

HEADPHONES
Balanced Armature Low Resistance
Type 1, 11 pair; Type 2, 7 11 pair.
High Resistance
12 6 pair.
Moving Coil
Type 3, 11 pair.
Lightweight High Resistance
14 6 pair.

TRANSMITTER RECEIVER TYPE TR9H
Consists of Transmitter type T1896 and Receiver R1132 in one case. This is a 9 valve Battery operated Unit covering 4.3 Mc/s to 6.6 Mc/s. Crystal controlled, complete with valves, 30 -, plus 7/6 packing and postage.

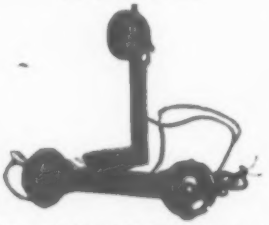
TANNOY HAND MICROPHONES
With switch in handle, 4 11.

MOVING COIL MICROPHONE INSERTS
A moving coil loudspeaker or microphone unit, 1¼in. dia., 3/-.

CRYSTAL MICROPHONE
An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and disc recording and sound projectors. Price 23 6.

POST OFFICE DESK TELEPHONES
Complete with screened lead and plug. Brand new in maker's carton 12 6, post and insurance 1/6. Special quotations for quantities.

TELEPHONE KITS



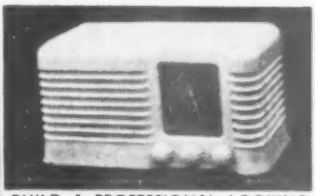
Build yourself a 2-station telephone with two complete units as illustrated. Uses balanced armature units. No batteries needed. 15 - Set of two Units. With diagrams.

BALANCED ARMATURE EARPIECES
These extremely sensitive phone units make excellent Earphones and Microphones. Used as Telephones, loud signals can be heard over a considerable distance. No battery of any kind is needed. 2 6 each.

WILLIAMSON AMPLIFIER OUTPUT TRANSFORMERS
To designer's specification, 63 -.

FRACTIONAL H.P. MOTOR
A 50 v. 3 phase A.C. motor, 1/40th h.h.p. by famous maker. Supplied complete with resistor, condenser and circuit diagram to convert the motor to 4 h.p. for use on 240 v. single phase A.C. mains. Brand new, 25 -, plus 2 6 carriage and packing.

MAINS NOISE ELIMINATOR KIT
Two specially designed chokes with three smoothing condensers with circuit diagram. Cuts out all mains noise. Can be assembled inside existing receiver, 6 - complete.



BUILD A PROFESSIONAL LOOKING RADIO AT *LESS* THAN HALF TO-DAY'S PRICE

We can supply all the parts to help you.

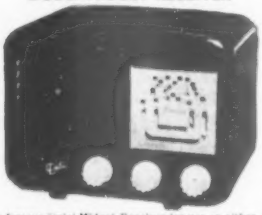
Bakelite Cabinet (Brown or Ivory)	17 6
Packing and insurance	2 6
Punched chassis, 3-wave plus rectifier T.R.F.	3 9
Engraved Glass Dials, 180-550 and 800-2,200 m. With station names, new wavebands.	1 -
T.R.F. Coils, 180-550, 800-2,200 metres, pair	6 6
Drum (3¼in. diam.)	1/-
Driving head	1/-
Double pointer	4d.
Spring	3d.
Nylon cord (yard)	6d.
Dial Front Plate	2 6

SEND 1/6 FOR EASY TO FOLLOW POINT TO POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver illustrated above.

THE COMPLETE KIT
to construct a 3 valve plus rectifier TRF Receiver for use on 200/250 v. A.C. mains can be supplied at
£8 9 6 plus 2/6 packing and carriage.

Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point to point diagrams are supplied, making construction very simple. The Dial is illuminated and the Receiver housed in a Bakelite Cabinet size 12in. x 5in. x 6in. presents an attractive appearance. The valve line-up is
717A—H.F. Pentode. VR116—Detector.
ATP4—Output, and Metal Rectifier.
Waveband coverage is for the medium and long bands. Choice of Walnut or Ivory coloured Cabinet.

SENSATIONAL OFFER
DULCI MIDGET RECEIVER



The famous Dulci Midget Receiver for use on either A.C. or D.C. mains, 200/250 volts. This is a 2-waveband 4 v. Superhet Receiver covering the short waveband from 13.6 metres to 30 metres, and the medium waveband from 200-550 metres. Can be supplied in either ivory or brown bakelite cabinet.
Size 7¼in. length.
6in. height.
8¼in. depth.
This receiver is fully covered by the manufacturer's guarantee. Price £3 15 -, carriage paid

THIS OFFER CANNOT BE REPEATED

BATTERY CHARGER KITS
All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. 50 cycle MAINS.
Cat. No.

2002	Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator	£1	2	6
2003	Charges 12 volt accumulator at 1 amp.	£1	7	6

ACCUMULATORS
By world-famous maker, 2 volt 16 a. 4 11

H.T. ELIMINATOR AND TRICKLE CHARGER KIT
All parts to construct an eliminator to give an output of 120 volts at 20 m.A., and 2 volts to charge an accumulator. Uses metal rectifier. £2.

THREE-PIECE AERIAL
Ex-U.S.A. 12ft.—3 4ft. screw-in sections of copper-plated steel, highly flexible with non-stick screw jts. tapering ¾in. to ¼in. *Brand new* in container, 6/9, packing and carriage 1/6. Insulated Base 2 6.

EX-U.S.A. U.H.F. AERIAL
with untuned detector stage, consisting of V.R. 92 valve, etc. Brand new, in carton 5 -.

ADJUSTABLE BENCH LAMP
Complete with flex, impeditor and reflector, 25 -. Post and insurance 2 -.

BURGOYNE SOLDER GUNS, 75/-

TUNING CONDENSERS
4-Gang .0005 mfd. Ceramic insulator, ¼in. spindle, 5 -; 3-Gang, .0005 mfd., ¼in. spindle 7 6.

GERMANIUM CRYSTAL DIODES
Wire ends, midget size. The ideal Crystal Detector. G.E.C. or B.T.H. 4 6.

PREMIER SUPERHET COILS
16-50, 180-550, 800-2,000 metres, set with circuit, 10 6

METAL RECTIFIERS—FULL WAVE
6 v. 1 amp., 4 -; 17 v. 1 amp. 8 -.
E.H.T. Pencil Type:
Output: 650 v. 1 mA., 4 7 each.
1,000 v. 1 mA., 6 - each.

BRAND NEW—**CAR BATTERIES**

Delco-Remy in original cases.
6 v. 70 a., £3 17 6, plus 7/6 carriage and packing.
6 v. 90 a., £4 15 -, plus 7/6 carriage and packing.
6 v. 100 a., £4 17 6, plus 7/6 carriage and packing.
6 v. 140 a., £5 10 -, plus 7/6 carriage and packing.
12 v. 85 a., British made, £5 10 -, plus 7/6 carriage and packing.
6 v. 170 mA., in teak case, £5 10 -, plus 7/6 carriage and packing.

SPECIAL OFFER of
ADMIRALTY REFLEX-RE-ENTRANT P.A. LOUDSPEAKERS

Vicoil 7 ohms. Matching transformers 4-5-1 and 6-1 ratios with volume control at max. Very sensitive and directional. Single Unit, 55 -. Twin Units, 75 -. Plus 5/- carriage and packing.

SUPER QUALITY TELEVISION MAGNIFYING LENS
To suit 5in., 6in., or 7in. Tubes. Increase picture size considerably. 25 - each.

WHITE RUBBER MASK
For 6in. Tube, 8 6.

P.M. MOVING COIL LOUDSPEAKERS
(3 ohm voice coils)

2in. Goodmans	18/-	6in. Truvox	12 6
3in. Pleasey	15 -	8in. Pleasey	14 6
5in. Pleasey	17 6	10in. P.M.C.	27 6
5in. Truvox	12 6	12in. Truvox	70 -
3in. Rola	13 6		

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Telephones AMBassador 4033 PADdington 3271/2

OPEN UNTIL 6PM ON SATURDAYS

IMPORTANT ANNOUNCEMENT: WE CANNOT ACCEPT RESPONSIBILITY FOR, NOR CAN WE GUARANTEE ANY—

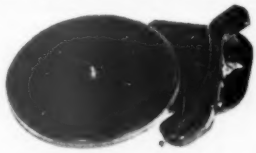
PREMIER RADIO Company

RADIO B. H. MORRIS & CO. (RADIO) LTD. TELEVISION

PREMIER TABLE RADIOGRAM CABINET (WALNUT FINISH)

Outside dimensions: 34½in. high, 14in. deep, 14½in. wide. Price £2 5 -, plus 5 - carriage and packing.

Special Offer—**AT ALMOST HALF PRICE PLESSEY GRAMOPHONE UNITS**



The Motor, Tone arm, and Magnetic Pick-up is in one Unit, with Automatic stop and start.
For use on 200/250 v. A.C. mains 50 cycles. Limited quantity only. **£4 19 6**, plus 5 - packing and carriage.

RADIO CABINET (WALNUT FINISH)

Outside dimensions: 18½in. high, 11½in. deep, 16½in. wide

Price **£2 2 6**, plus 7 6 carr. pkg.

GRAMOPHONE UNITS

Collaro RC500 Autochanger Unit, single speed, 78 r.p.m., already mounted on metal frame, ready to drop into cabinet	£16 10 0
Collaro Autochanger 3-speed Unit, including Crystal Head for long playing and standard recordings	£18 14 1
Connoisseur 2-speed Gramophone Unit, LS8S Pick-up	£22 16 8
Pick-up and 2 heads for above	£10 0 8
Conrad Rim Drive Gramophone Unit. Less Pick-up arm, 78 r.p.m.	£4 3 10
Ditto, 33 r.p.m.	£4 7 5
Decca 3-speed Rim Drive Gramophone Unit. LS8S Pick-up	£7 3 4
Decca Single-speed Rim Drive. LS8S Pick-up, 78 r.p.m.	£3 14 4
Ditto, 33 r.p.m.	£3 14 4
Decca Pick-up with 2 heads, one long playing and one standard	£7 0 0
Plessey Autochanger 3-speed magnetic head, plays mixed records	£23 13 0
Collaro Rim Drive Magnetic Unit, 78 r.p.m.	£6 11 4

Plus Packing and Carriage 5 -.

ALL THE ABOVE ARE FOR USE ON A.C. MAINS ONLY.

PX25 AMPLIFIERS

A superb push pull 15 watt model with all the latest refinements, extended tone control range, 3in. moving coil panel meter for current and distortion checks, oil filled condensers, fuses in circuits, two smoothing chokes and although in a steel case the front panel extends to fit on a 19in. standard rack. The high gain circuit of latest design will give full volume from the smallest input. 300 ohm output. Less valves. **£5 5 -**, plus £1 15 - carriage, packing and insurance.

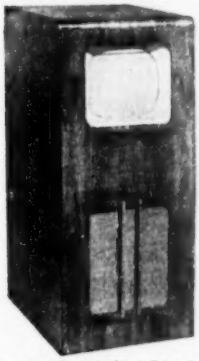
PREMIER 3-BAND COIL PACK

Consists of a wired and aligned Coil Pack of the most Modern Type incorporating such features as Air Dielectric Trimmers, Litz wound medium wave coils, Tuned R.F. stage, covers 13-14, 40-120, 200-557 metres. Dimensions of pack: 6in. × 4½in. × 2¾in. Complete circuit is supplied. Price **29 6**.

PREMIER 4-BAND COIL PACK

Consists of a fully wired and calibrated Coil Pack of the latest type. 5 Position Switch includes a Gram. position. Waveb ands covered: 13.5-22 metres (22-13.8 Mc/s), 51-190 metres (5.9-1.57 Mc/s), 190-540 metres and 900-2100 metres. Air Dielectric Trimmers on all Short-wave Coils. Unit consists of 3 Screened Sections, Aerial, R.F. and Oscillator. Dimensions of Pack, 6in. × 4½in. × 2½in. Price with circuit diagram, **£4 11 6**.

PREMIER TELEVISOR CABINET FOR 12in. TUBE TELEVISOR



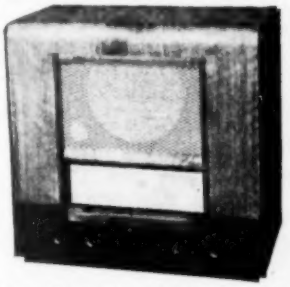
A handsome walnut finished cabinet. Primarily designed for our own Kits. They are quite suitable for most of the kits published in the various Radio periodicals. For this reason the holes for control knobs have not been drilled. A baffle board suitable for a 10in. Loudspeaker is provided. Outside dimensions 33½in. high, 20½in. deep 16in. wide **£9 9 -**, plus 7 6 packing and carriage.

CORRECT ASPECT WHITE RUBBER MASK

For 12in. Round or Flat faced Tube. 16/11.

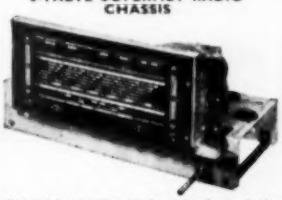
RADIO CABINET (WALNUT FINISH)

Outside dimensions: 16½in. high, 9in. deep, 17in. wide



A beautifully made cabinet. **£3 10 -**, plus 2 6 carr. pk.

5-VALVE SUPERHET RADIO CHASSIS

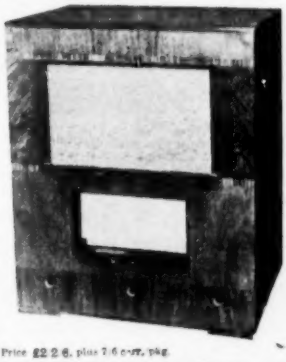


Drilled and fitted with 5 Amphenol Octal valve holders, aerial, earth and gramophone sockets, necessary cut-outs for all control mountings, mains transformer and 500 PF. tuning gang condenser. Fitted with Full Vision Drive assembly consisting of unbreakable Perspex 3-coloured scale for long, medium and short wave bands. Calibrated in metres, kilocycles and station names. Price **39 6**.

AS A SPECIAL OFFER—CABINET ILLUSTRATED ABOVE AND CHASSIS, TOGETHER £5. 5. 0. Plus 7 6 Carr./Pkg. & Insurance.

RADIO CABINET (WALNUT FINISH)

Outside dimensions: 17in. high, 11in. deep, 16in. wide



Price **£2 2 6**, plus 7 6 carr. pkg.

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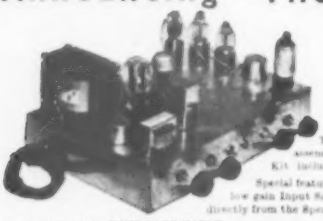
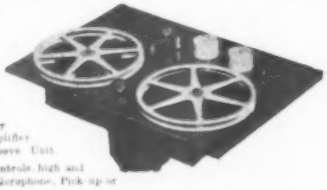
—KIT OR COMPONENT SOLD AS A PREMIER PRODUCT BY FIRMS OTHER THAN OURSELVES

PREMIER RADIO Company

RADIO — S. H. MORRIS & CO. (RADIO) LTD. — TELEVISION

Announcing—The PREMIER MAGNETIC TAPE RECORDING KIT





£29 . 8 . 0

(Carriage and Packing 15/-) including all parts, Valves, Cabinet, Loudspeaker etc., but excluding Microphone.

The Kit Incorporates the **LANE TAPE TABLE** already assembled and ready for use, and a 6 Valve specially designed Amplifier Kit including Bias and Erase Oscillator for use with the above Unit.

Special features of the Amplifier include separate Bass and Treble lift controls, high and low gain Input Sockets, Record/Playback indicator, etc. May be fed from Microphone, Pick-up or directly from the Speaker terminals of your radio.

Specification of the **LANE TAPE TABLE** :—

HEAVY FLYWHEEL. Made to high standards and incorporating a heavy flywheel ensuring true running and low level of "Wow" and "Flutter" throughout the full length of tape.

FAST RE-WIND. Provision is made for fast re-wind and the mechanical action is simple, ensuring reliability through long life.

HEAVY DUTY MOTOR. The Motor is HEAVY DUTY model with AMPLE RESERVE of power.

HIGH FIDELITY RECORD PLAYBACK (1 hour approx. playing). The Tablets fitted with High Fidelity record playback and separate erase heads, both of which are enclosed in MU-METAL shields. The heads are half track size allowing app. 1 hour playing from standard 1,200ft. reel of tape. All standard heads are wound to high impedance.

TAPE SPEED 7½in. sec. **A.C. 200/250 50 Cycles only.**

A Well Made Walnut Finished Table Cabinet is Supplied to house the complete unit.

Moving Coil Microphones suitable for use with the above are available from stock.

As is usual in all **PREMIER KITS** every single item down to the last nut and bolt is supplied. The Chassis is punched and lay-out diagrams and theoretical circuits are included. Each Unit may be purchased separately:

Lane Tape Table £16.10.- 10/- packing and carriage.
Premier Amplifier Kit including Sin. Speaker £7.19.6. 2/6 packing and carriage.
Cabinet £4.18.6. 5/- packing and carriage.

WORKING MODELS MAY BE SEEN AT THE ADDRESS BELOW

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OPEN UNTIL 6PM ON SATURDAYS

In accordance with our declared policy of manufacturing only the finest and most modern equipment,

PANDA PROUDLY PRESENTS THE PR-120-V

The FIRST Table Top Tx to incorporate the following desirable features :—

* **T.V.I.**—Incorporating the absolute latest in T.V.I. proofing. You can now live with T.V.

* **FLEXIBILITY.**—Band-switched 3.5, 7, 14, 21 and 28 Mc/s.

* **THE COMPLETE "TABLE TOPPER"** Speech Amplifier, modulator and all power supplies built into one modern table top cabinet.

* **QRO.**—120 watts of 100 per cent. modulated phone and 150 watts of C.W.

* **VERSATILE.**—High stability calibrated V.F.O. incorporated.

* Harmonic Check facility. Fully metered. H.T. interlock and full safety precautions. Embodied variable excitation control. Break-in facilities provided. Output impedance 50—100 ohms unbalanced line.

In fact, IT HAS EVERYTHING!

With a key, mike and power plug you can work WHO you want WHEN you want with the PR-120-V.

The PR-120-V is now in production. Price **£125.**
All orders will be dealt with strictly in rotation. Export inquiries will command priority.

The PR-120-V is the latest product of the PANDA organisation and is another "first." A new piece of "PANDA" (Regd.) Equipment.

PANDA RADIO CO., 58 School Lane, Rochdale
Tel. : 47861. Grams : PANDA, ROCHDALE

COILS • COILS • COILS

T.R.F. • SUPERHET • FILTERS • PACKS
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COIL FORMERS
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STAND-OFFS
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Send for Particulars and Samples

AMPLEX APPLIANCES (KENT) LTD.
19 DARTMOUTH ROAD, HAYES, BROMLEY, KENT
(RAVensbourne 5531)

CLYDESDALE

Bargains in Ex-Service Radio and Electronic Equipment

COMMAND RECEIVER CCT CBY46129

U.S.S. version of the BC-453 for that Sharp channel "Q-Fiver," range 550-1500kcs with 6 valves, 3 12SK7, 12SG, 12SK7, three gang tuning cond., etc., etc. Dim.: 11 × 8½ × 8in. Finish black, less dynamotor.

CLYDESDALE'S PRICE ONLY **70/-** POST PAID

Circuits of BC-453 available at 1/3.

COMMAND TRANSMITTER CHASSIS

Partly stripped by the M.O.S., less valves, coil winding, crystal and dynamotor, but otherwise fairly intact. A fine basis for ideas in V.F.O. or Tx. Original valve types 2/1625, 1626, 1629. Conversion suggestions and circuits supplied. In aluminium case. Dim 7½ × 5 × 8½in. Wgt. 8lb.

CLYDESDALE'S PRICE ONLY **15/-** POST PAID

COMMAND SPEECH MODULATOR BC-454

With valves, 1625, 12J5, VR150/30, modulation trans., R.F. Choke, Mic. trans., relays, etc., etc. Enclosed chassis 10½ × 7½ × 6½in., less dynamotor.

CLYDESDALE'S PRICE ONLY **25/-** CARRIAGE PAID

TEST EQUIPMENT IE-65-A

Command series Test Gear with 3 Antennae, 3 Test Units, Mod. BC-456-B (or K) with dynamotor, Antenna Relay, 2 Radio Control Boxes, 2 Racks, 6 Mountings, IF Shunt Unit, Control Unit MC-237, and 71 Cable Assy.

CLYDESDALE'S PRICE ONLY **£22 10 0** CARRIAGE PAID

APS-13 CHASSIS

Less valves, and partly stripped by M.O.S. Transmitter section removed, contains 7 tropicalized 30 Mc/s. IFT, dynamotor, RFO and other valveholders, relay, etc., etc. Dim.: 15½ × 7½ × 7in. Wgt. 12½lb.

CLYDESDALE'S PRICE ONLY **21/-** POST PAID

BC-625-A TRANSMITTER CHASSIS

Less valves, and partly stripped by the M.O.S. R.F. section in good order. Dim.: 15½ × 7½" × 6in. Separate Modulation Transformer and Choke supplied.

CLYDESDALE'S PRICE ONLY **29 6** CARRIAGE PAID

JEFFERSON TRAVIS UF-2 TRANSCEIVER CHASSIS

Partly stripped by the M.O.S., less valves, tuning inductance, osc. connections, but otherwise fairly intact. A fine basis for a transportable type two-way radio. Original frequencies 60-75 Mc/s. Valve types 2/6Y7, 12J5. The unit comprises two chassis, with controls and speaker mounted on chrome plate etched steel panels, housed in cabinet finished black crackle, dim. 10½ × 15½ × 8½in.

CLYDESDALE'S PRICE ONLY **£2** CARRIAGE PAID

JEFFERSON TRAVIS UF-1 POWER SUPPLY

Complete self contained vibrapack. Input 12 volts. Output 120/180 v. D.C. 30/50 mA. Choke capacity smoothed and 2 L.T. taps. Unused but vibrator contacts stuck due to long storage. Complete with synchronous vibrator, smoothing conds., etc., in metal case, dim.: 7 × 3 × 4in.

CLYDESDALE'S PRICE ONLY **25/-** CARRIAGE PAID

U.S.A. PATT. MORSE KEY TYPE CJB

Enclosed contact type as made by J. H. Bunnell & Co. and used in American Aircraft. Finish black crackle complete with contact and tension adjusting screws. Dim. 3½ × 1¼ × 2in.

CLYDESDALE'S PRICE ONLY **12/6** POST PAID

DINGHY TELESCOPIC MAST

A lightweight (4 oz.) Mast for many uses. Car Aerial, Camera tripod, fishing rod, etc. Made of aluminium, 7 sections. Closed 14¼in. Extended 7ft. 6in. Diams., base ¾in., top 7/16in.

CLYDESDALE'S PRICE ONLY **6/-** POST 6d.

NEW LIST NO. 8

Giving details and illustrations of ex-services items and cancelling all previous lists and supplements.

Now Ready—Price 1/6.

Price credited on first purchase of 10/- or over.

METAL (MINE) DETECTOR NO. 4

Ref. ZA24238

Of Cdn. design and construction, using 1T4 pentodes. Comprising TC Amplifier, Search Coil, Sweep pole, Control Box, Headphones, Test Unit and Knock sack. Complete less batteries in fitted transit case.

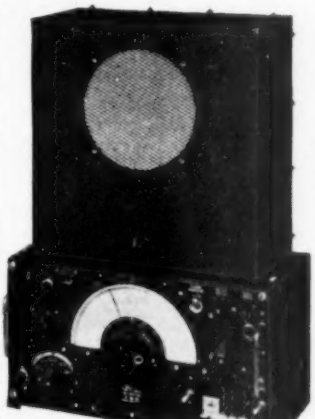
CLYDESDALE'S PRICE ONLY **£6 19 6** CARRIAGE PAID

FLUXMETER WY.0023

Designed to calibrate the field of Magnets within the range of 500 to 4,000 gauss and to determine their polarity. Complete with probe unit and contained in a hardwood case with hinged lid and handle. Instructions on lid. Dim.: 12½ × 9 × 6in.

CLYDESDALE'S PRICE ONLY **£5** CARRIAGE PAID

THE R.1155 RECEIVER FOR A.C. MAINS



Receiver R.1155 with 7 valves, 5 wavebands, 18-7.5 Mc/s. (17-40 m.), 7.5 - 3 Mc/s. (40-100 m.), 1,500-600 kc/s. (200-500 m.), 500-200 kc/s. (600-1,500 m.), 200-75 kc/s. (1,500-4,000 m.). BM Drive BFO, etc., etc., Dim.: 16¾ × 9 × 9in. Power Output Pack with 2 valves 8in. L.S., etc., etc. Dim.: 14 × 14 × 7in. Complete with Hooking cable and circuits.

CLYDESDALE'S PRICE ONLY **£18 10 0** CARRIAGE PAID

HEADSET HS-30

With cord CD-874 and jack plug PL-55 Miniature earpieces 80 ohms each, fit into ear and are rubber padded for comfort. U.S.A. made 160 ohms impedance overall.

CLYDESDALE'S PRICE ONLY **21/-** per pair POST PAID

U.S.A. THROAT MICROPHONES

Pair carbon Button throat pieces with strap lead and plug.

CLYDESDALE'S PRICE ONLY **5/-** POST 6d.

THROAT MICROPHONES

Pair electro-magnetic throat pieces (7.5 ohms. each) with strap, lead and jack plug Ref. ZA13935.

CLYDESDALE'S PRICE ONLY **3/6** POST 6d.

THE R3601 RECEIVER UNIT

A 14-valve Receiver and dual chassis radar receiver for 223 Mc/s with 13 Mc/s I.F. strip, high cycle power sections Valves 5/8Pt1, 4/EA50, 2/EF54, EF50, EC52, 6V6 and VU39A Rectifier, pins antenna switch, relay, etc., etc. Housed in metal case 18 × 9 × 8in., finish light blue.

CLYDESDALE'S PRICE ONLY **£4 12 6** CARRIAGE PAID

THE "194" I.F. STRIP

Ref. 14DB 6673. Less Valves, 6 stage sub-assembly chassis for 12.35 Mc/s. with 6 wired-up valveholders, plus condensers and resistors. Dim.: 17 × 3 × 7in.

CLYDESDALE'S PRICE ONLY **17 6** each POST PAID

I.F. A.F. AMPLIFIER UNIT R1355

The popular T.V. Sound and/or Vision Unit. 5 IF stages, 10 valves 8 VR65 (SP61), 6U40, VU120A, etc., etc. In metal case 18 × 8½ × 7½in. Used, good condition.

CLYDESDALE'S PRICE ONLY **67 6** CARRIAGE PAID

R.F. UNIT TYPE 27

In original carton

The ideal S.W. Converter for T.V. variable tuning. Range 80-65 Mc/s. 2/VR136 (EF54), VR137 (EC52). Output 7-8 Mc/s. Metal case 8½ × 7½ × 4½in.

CLYDESDALE'S PRICE ONLY **63 -** each POST PAID

SPECIAL OFFER
R.1355 UNIT PLUS R.F. 27

CLYDESDALE'S PRICE ONLY **£5 17 6** CARRIAGE PAID

INDICATOR UNIT TYPE 62

In maker's original case

Containing: VCR97 C.R.T. with mu-metal screen, 100 k/c. Crystal unit 10XC/2, 10/VR65's (SP61) 2/VR54's (EB34), 2/VR92's (EA50), plus various pots, switches, H.V. conds., resistors, etc., built on metal chassis set in box 18 × 8½ × 11½in. All controls brought to front panel beside viewing screen.

CLYDESDALE'S PRICE ONLY **£5 9 6** CARRIAGE PAID

Also available in used, fair condition.

CLYDESDALE'S PRICE ONLY **79 6** CARRIAGE PAID

THE 5.CPI CATHODE RAY TUBE IN ORIGINAL CARTON

A 5in. electrostatic tube. Heater vtg. 6.3 v. 0.6 A H.T. 4,000 v. max. intensifier gives high definition. Trace colour green, short persistance.

CLYDESDALE'S PRICE ONLY **£1/15/0** POST PAID

E.H.T. TRANSFORMER

Primary 0/200-230-250 VAC. Secondaries 2,000 v. 5 mA. 4V1 1A. 2-0-2 v. 1A. Upright mtg. dim.: 3½ × 3½ × 3in.

CLYDESDALE'S PRICE ONLY **32/6** POST PAID

TIME-BASE TRANSFORMER

Primary 200, 230, 250 VAC. Secondaries 250-0-250 v. 150 mA. 6.3 v. 6 A, 5 v. 2 A. Upright mtg. dim.: 4½ × 4½ × 4½in. Wgt. 8½lb.

CLYDESDALE'S PRICE ONLY **37/6** POST PAID

RECEIVER TRANSFORMER

Primary 200, 230, 250 VAC. Secondary 350-0-350 v. 100 mA, 6.3 v. 6 A, 5 v. 2.5 A. Upright mtg. dim.: 4½ × 4½ × 4in. Wgt. 7½lb.

CLYDESDALE'S PRICE ONLY **32/6** each POST PAID

PLUGS AND SOCKETS

6-way "Jones" type Cable 8kt., **3/6** each, post 3d.; 4-way Diecast "W" Cable 8kt., **3/-** each, post 3d. 6-way Diecast "W" Cable 8kt., **3/6** each, post 3d.; Co-axial "Pye" type Cable 8kt., **1/-**, post 3d.

BAKELITE HOLDER FOR VCR97

Side Contact Fitting

CLYDESDALE'S PRICE ONLY **2/6** POST 3d.

CIRCUITS AVAILABLE

IF AF Unit R.1355, **1/3**; Rec. Unit R.3601, **1/3**; RF Unit Type 24, **1/3**; RF Unit Type 25, **1/3**; RF Unit Type 26, **1/3**; RF Unit Type 27, **1/3**; Ind. Unit Type 6K, **1/3**; Ind. Unit Type 62, **1/3**; Ind. Unit Type 62A, **1/3**; Ind. Unit Type 116H, **1/3**; Ind. Unit Type 116, **1/3**; Ind. Unit Type 116A, **1/3**.

VIEWMASTER TELEVISION

Build it yourself Circuits with templates and all data. London "A," **5/-**; Sutton Coldfield "B," **5/-**; Holme Moss "C," **5/-**; Kirk-o-Shotts "D," in preparation.

VIEWMASTER TELEVISION

All components normally in stock. Subject to mfgr. production. Coils for All Areas including: Holme Moss and Kirk-o-Shotts at **2/-** each; Set of Coils, Filter and Choke, **30/-**, Post paid.

Large and varied selection of Books on Radio and Television always available, also Circuits of Ex-service Units.

Order direct from —

CLYDESDALE SUPPLY CO. LTD. 2 BRIDGE STREET GLASGOW . C5

Phone : South 2706/9 Branches in Scotland, England and Northern Ireland

MAINS TRANSFORMERS

These transformers are all famous radio manufacturers' surplus and are fully interleaved, impregnated and guaranteed.

Primary 200-250 v. P. & P. on each 1/6 extra.

250-0-250, 100 mA., 4 v. 4 amp., 4 v. 2 amp., upright or drop-through, 16/-.

300-0-300, 100 mA., 6 volt 3 amp., 5 volt 2 amp., 17/6.

320-0-320, 100 mA., 6 volt 3 amp., 5 volt 2 amp., 17/6.

320-0-320, 120 mA., 6 volt 4 amp., 5 volt 2 amp., 25/-.

280-0-280, 120 mA., 6 v. 6 amp., 5 v. 2 amp. Less fixing clamps, 18/6.

250-0-250, 100 mA., 6 v. 3 amp., 4 v. 3 amp., 4 v. 3 amp., 17/6.

250-0-250, 60 mA., 6 v. 4 amp. (to be used on common heater chain with 6 × 5 rectifier), 13/6.

280-0-280, 80 mA., 6 v. 3 amp., 4 v. 2 amp., drop-through, 14/-.

Drop thro', 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., 14/6.

Semi-shrouded, drop-thro' or upright mounting 280-0-280, 80 mA., 4 v. 6 amp., 4 v. 2 amp., 12/6.

Auto-wound H.T. 280 volts at 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separate 4 v. 3 amp. rectifier winding (upright or drop-through), 10/6.

350-0-350, 120 mA., 4 v. 6 amp., 4 v. 3 amp., drop-through, 21/-.

Auto-transformer, various combinations of voltages including 110 v. 70 watt, and 3/4 volts windings at 1 amp., 2 volt 1 amp., drop-through or upright mounting, 10/6.

Heater Transformer Pri. 200-250 v., 6 v. 1½ amp., 6/-; 13 v. 1½ amp., 6/-; 2 v. 2½ amp., 5/-, P. & P. each 9d.

ELECTROLYTIC CONDENSERS

Ex-Govt. 8 mfd. 500 v. wkg., size 3½ × 1⅛in., 2 for 2/6, post paid.

P.M. SPEAKERS

	with trans.	less trans.
2½in.	—	13/6
3½in.	—	11/6
5in.	15/-	12/6
6½in.	14/6	11/6
8in.	17/-	14/6

10in. M.E. Speaker Field Coil, 1,100 ohms, speech coil 2-3 ohms, 17/6.

P. & P. on each of the above 1/- extra.

Constructor's Parcel, comprising chassis 10½ × 5½ × 2in. with speaker and valve holder cut-outs, 5in. P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium iron cored, four valve holders 20K volume control and wave-change switch. Post paid 21/-.

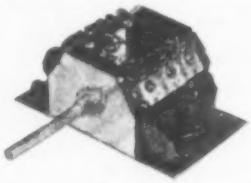
Constructor's Parcel, comprising 4 valve T.R.F. chassis, 8½ x 4 x 1⅛in., 3 VR65A (using one as an output valve), heater trans. pri. 200-250, choke, OP trans. 3 valve holders, pair medium wave coils, 47k. pot, twin gang, and scale, 20/-, post paid.

Volume Controls, by famous manufacturer. Long spindle less switch, 5 k., 50 k., 500 k., 1 meg. 2/6 each. P. & P. 3d. each.

Frame Blocking Oscillator Transformer, 4/6.

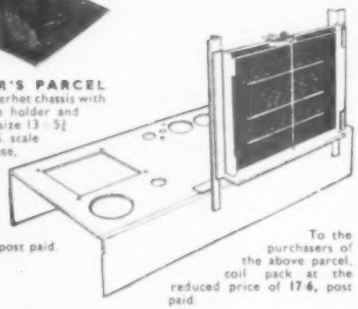
D. COHEN

RADIO & TELEVISION COMPONENTS



Three Wave-Band Coil Pack, iron cored coils, 16-50, 180-550, 1,000-2,000 metres. I.F. frequency 465 Kc. Size, 4½ × 1⅝in. × 2⅝in., 24/-, post paid. Double ended perspex trimming tool given free with each pack.

CONSTRUCTOR'S PARCEL comprising 5-valve superhet chassis with transformer I.F., valve holder and transformer cut-outs, size 13 × 5½ × 2½in., with L.M. & S. scale size 7 × 5in. Back plate, two supporting brackets, drive drum pointer two speed spindle, spring, three pulleys and five international Octal valve holders, 11/6, post paid.



To the purchasers of the above parcel, coil pack at the reduced price of 17/6, post paid.

P.M. Focus Unit. For any 9in. or 12in. tube, except Mazda 12in., state tube, 12/6.
P.M. Focus Unit. For Mazda 12in., 15/-.

Pensolda 6 volt Light Weight Soldering Iron, weight 3½ ounces complete with 1½ yards circular flex, 8/6. Post & pack, 1/-. Complete with suitable heater transformer Primary 230 250 volts, 10/6. Post & pack., 1/9. Transformer not sold separately.

PERSONAL PORTABLE CABINET in cream plastic, size : 7in. x 4½in. x 3in., complete with 4-valve chassis. Will take miniature 90 volt and 7½ volt batteries, 13/6, post paid.
MIDGET COMPONENTS to fit the above comprising twin gang ⅝in. diameter, ⅞in. long. (The dimensions of this gang are slightly deeper than a standard volume control.) Pair Medium and Long iron cored T.R.F. Coils ⅝in. long × ⅜in. wide complete with a 4-valve all-dry circuit, tuning scale and pointer knob. All the items 10/-, post paid.
2½in. **SPEAKER** to fit the above, 13/6, post paid.
O.P. TRANSFORMER, 5/-, post paid.
MINIATURE SWITCHES, 2 pole 1 way, 1/9, 1 pole 4 way, 1/9.
We can supply all the miniature resistors and condensers.
The cost of all components for the above receiver is approximately £3 (less valves and batteries).

MAINS or BATTERY SUPERHET PORTABLE COILS. Comprising medium wave frame aerial and long wave loading coil, used as aerial coils. Midget iron cored screened L.M osc. coils, complete with circuit I.F. frequency 465 Kc., 9/6.
6 IRON CORED LONG, MEDIUM and SHORT SUPERHET COILS coupling winding on all bands, 13.5-50, 180-550, 1,000-2,000 metres, complete with circuit, 8/6.
METAL RECTIFIERS, 250 v. 60 mA., latest midget Selenium type, 6/6 post pd.
OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 2 ohms speech coil, 4/9; Push-Pull 6 v. 6 matching 10 watt 2 ohms speech coil, 6/9. 42-1 speech coil 2 ohm with extra feed back winding, 4/3; Miniature 42-1 2 ohm speech coil, 3/3.
SET OF 3 BROWN KNOBS marked "wave change," "tuning," and "volume," 1/6.

6-pin 6 volt synchronous vibrator	8/6
6 volt standard 4-pin vibrator	8/6
Vibrator transformer 250-0-250 80 mA. 6 volt Pri.	8/6

EXTENSION SPEAKER CABINET
Polished in a pleasing light and dark shade. Complete with an 8in. P.M. Rubber feet and back. Size 10in. × 10in. × 4½in., 22/6, post paid.

TELEVISION MASKS

White Rubber, 9in. with glass 10/6. White Rubber, 12in. with glass, 15/-. 15in. white rubber mask, soiled, 12/6, plus 1/- P. & P.

All-Dry A.C. Mains Supply Unit, size 3½in. long × 2⅝in. wide × 1⅝in. deep. We can supply a complete all-dry circuit, using the above Midget Components to incorporate the above Power-Unit, 19/6, post paid with circuit.

Midget Bakelite Cabinet. 7in. × 5½in. × 5in. c/w 5-valve 5 h. chassis med. long wave scale and back (takes std. twin gang condenser and 3½-in. speaker). 15/-. P. & P. 1/6.

Wave Change Switches. 6-pole 3-way, 2/-; 4-pole 3-way, 1/9; 5-pole 2-way midget, 1/9; 5-pole 3-way, 1/9; 3-pole 3-way, 1/9; 2-pole 1-way midget, 1/3; 2-pole 1-way, 1/3; 9-pole 3-way, 3/6. P. & P. 3d. each.

Pre-Aligned Midget 465 Kc. Q. 120, 9/- per pair, post 6d.

Miniature 465 Kc. I.F.s. Q.120, per pair, 10/-.

465 Kc. Midget I.F.s. Q.120, size 1⅝in. long, 1in. wide, ⅝in. deep, by very famous manufacturer. Pre-aligned adjustable iron dust cores. per pair, 12/6.

465 Kc. Iron Cored. Q120, size 3½ × 1in. dia. 7/6.

Iron Cored 465 Kc. Whistle Filter, 2/6.

T.V. Chassis. Size 9½ × 9½ × 3½in., 3/-.

Standard 465 Kc. I.F.'s. Q.120 iron cored, 3½ × 1⅝ × 1⅛in., per pair, 10/6.

Valve Holders. Paxolin international octal, 4d. each. Moulded international octal, 7d. each. EF50 ceramic, 7d. each. Moulded B7G slightly soiled, 6d. each.

Line Cord. 3-way 0.3 amp., 180 ohms per yard, 1/3 per yard.

Ceramic P.F.S. 3 each of the following : 330, 220, 180 and 82, 2/6.

Trimmers. 5-42 pf., 5d.; 10-110, 10-250, 10-450 pf., 10d. Three bank, 50 pf., 1/3. Four bank, 50 pf., 1/8.

Twin Gang .0005 Tuning Condenser, 5/-. With trimmers, 7/6. Post and packing 6d.

Twin Gang Midget .00037 with perspex dust cover and trimmers, 8/6. Post and pkg. 6d

Mains Droppers. 0.3 amp. 460 ohms, tapped 280 and 410, 1/6; 0.2 amp. 717 ohms, tapped at 100 ohms, vitreous, 1/6; 0.3 amp. 950 ohms, tapped 700 and 825, 2/6; 0.2 amp. 1,000 ohm, vitreous, tapped, 2/6. P. & P. on each 3d.

Volume Controls by famous manufacturer. Long spindle and switch ¼, ½, 1 and 2 meg., 4/- each; 20, 25 and 50 k., 3/6 each. Post and packing 3d. each.

THIS MONTH'S OUTSTANDING OFFER
Constructor's 465 kc. I.F. Kit, comprising 4 double Pye wound coils on ⅜in. Aladdin formers, 4 iron cores, 2 cans 3½ × 1⅝ × 1⅛in., four hundred pf. silver mica 5%, and two paxolin mounting panels. 4/6, post paid.

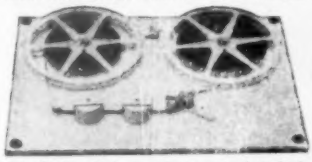
Terms of business : Cash with order. Dispatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 6d. up to 10/-, 1/- up to £1 and 1/6 up to £2. All enquiries and Lists, S.A.E.

23 HIGH STREET (Opposite Granada (Cinema), ACTON, W.3

Hours of Business : Saturdays 9—6 p.m. Wednesday 9—1 p.m. Other days 9—6.30 p.m. ***Telephone : ACOrn 5981***

GARLAND BROS. LTD

LANE PRECISION BUILT TAPE TABLE.

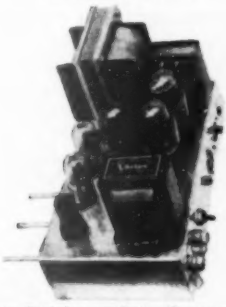


High fidelity high impedance record-playback and erase heads in mumetal shields. Heavy balanced flywheel giving freedom from "wow" and "flutter." Fast rewind. Heads are half-track, giving one hour's playing time with 1,200-foot reel of tape. **£16 10**-, plus carriage, etc., 10-. Demonstrations at Deptford and Lewisham.

TAPE DECK AMPLIFIER UE6. A six-valve record-playback amplifier suitable for use with high impedance heads. Features include variable bass and treble lift, recording level indicator and built-in oscillator supplying h.f. bias and erase sufficient for the highest coercivity tapes. Supplied in kit form, with punched chassis, all valves, components, circuits and full instructions. **£18 10**-, plus carriage 5-.

TAPE DECK AMPLIFIER HNES, a five-valve record-playback amplifier suitable for use with high impedance heads. With built-in oscillator supplying h.f. bias and erase. Supplied in kit form, with punched chassis, all valves and components, circuits and full instructions. **£7 10**-, plus 5- carriage.

AMPLIFIER ACIII.



7 valves (including rectifier) 10 watt push-pull output to 3 ohm or 15 ohm speaker. Supply available for tuner unit, etc. High and low gain inputs. Separate Bass and Treble controls. Negative Feedback. Varley mains and output transformers. Complete kit, with circuits and instructions, including circuit of suitable local-station quality tuner, **£9 19 6**, plus carriage 5-.

MODIFICATION KIT UE2. Enabling the use of Amplifier ACIII as a high-quality tape record-playback amplifier, for use with high impedance heads. Incorporating pre-amplifier, oscillator supplying h.f. bias and erase sufficient for the highest coercivity tapes and recording level indicator. In kit form, with all valves, components, punched chassis circuits and full instructions, **£4 4**-, plus 5- carriage.

MAGNETIC RECORDING TAPE. Emitape, Grade A, 600ft., 21-; 1,200ft., 35-. Scotch Boy (Durex), 1,200ft., 35-. **SPARE TAPE REELS.** 7in. (1,200ft.) plastic, 4- each.

LUSTRAPHONE MOVING COIL MICROPHONES. Type C5I. Response substantially flat to 8 kc/s. Impedance 20 ohms. Fitted with switch, **£5** each. Type C5I/Z. As above, but impedance 200,000 ohms, **£5 12 6** each.

AMPLIFIER 11 66. For those who desire good quality reproduction at low cost. Valve line-up is 6J5-6J5-KT66-5Z4. Output 5 watts. Volume tone and variable feedback controls. High grade output transformer. Chassis completely isolated from mains. Complete kit, including punched chassis, all valves and components, with circuits and instructions, **£5.12.6**. Amplifier wired and tested, **£6.12.6**.

METERS. All 2in. 0-4 a. D.C., **9 6**; 0-8 a. D.C., **9 6**; 0-20 a. D.C., **7 6**; 0-50 v. D.C., **7 6**; 0-300 v. D.C., **8 6**; 0-500 mA. THC, **7 6**.

CARBON HAND MICROPHONES. Type No. 3. With G.P.O. type carbon insert, press switch in handle, lead and jack plug. New and unused, **5**-each.

CATHODE RAY TUBES. 5CP1, Electrostatic intensifier-type C.R.T., diameter 5in. max. second anode voltage 2 kv., max. intensifier anode voltage 4 kv., medium persistence screen. Brand new in original crate or carton, **22 6** each.

CLOSE TOLERANCE SILVER MICA CONDENSERS. 10,000pF (0.01μF) plus or minus 2½. Ideal for service bridges, etc., 1- each, **9**- per doz. 1,000pF (0.001μF), ± 1%, 1.3 each. 100pF (0.0001μF) + 1% **9d.** each.

PULLIN MOTORS. Type A 3R. For 24 v. D.C. 3¼in. x 2¼in. x 2in., **8 6** each.

EDISWAN 3-SPEED AUTO-CHANGERS.

Plays eight 7B R.P.M., ten 33⅓ R.P.M. or 45 R.P.M. records. Replaceable double-pointed sapphire stylus, **£23 13**/-.

SPECIAL OFFER. EL50 6.3 v. 8 watt output pentode, **5**- each; **55**- per doz. Side contact valveholders to suit, **9d.** each.

WANTED . . . WANTED . . . WANTED

Radio, Television and Industrial Electronic Valves and Tubes of all types in Government and manufacturers' surplus; must be clean and unused in original boxes; no quantity too large.

Test equipment; condensers, resistors, chokes, transformers and components of all types, preferably in large lots; rotary and vibratory converters; A.C. and D.C. motors, geared and ungeared.

We are also open to undertake sole distribution of new products in radio, electronics and allied fields.

WANTED . . . WANTED . . . WANTED

HIGH CAPACITY PRECISION MICA CONDENSERS. We are again able to offer a complete range of these condensers, of which we have now sold over 25,000. Accuracy plus or minus 0.5 (point five) per cent. of stated value. Pure mica and copper foil or silver.

(a)	0.017970μF ... 1.3	(b)	0.023570μF ... 1.3
(b1)	0.027400μF ... 1.6	(c)	0.035020μF ... 1.6
(d)	0.040710μF ... 1.6	(d1)	0.048010μF ... 1.6
(e)	0.055820μF ... 1.6	(f)	0.065350μF ... 1.6
(f1)	0.082910μF ... 1.6	(g)	0.087460μF ... 1.6
(h)	0.100435μF ... 1.9	(i)	0.123750μF ... 1.9
(j)	0.147000μF ... 1.9	(k)	0.205276μF ... 2.-

Many standard values to better than 1 per cent. can be made up by parallel or other combinations of above, e.g., 4j + 2k = 1μF; 2k + g = 0.5μF; c + f = 0.1μF. (A table of over 150 series and parallel combinations of these condensers, invaluable in calculating filter networks, etc., is available on receipt of 2½d. stamp.

DECCA THREE-SPEED GRAM MOTORS. For 33⅓, 45 and 78 r.p.m. Instant single-lever speed selection. For A.C. only, 100-250 v. 50 cycle operation. Price (incl. P.T.), **£7 3 4**.

DECCA TURNOVER PICKUP. A high fidelity crystal pickup with turnover head (two sapphires) for use on the above or other multi-speed motors Price (incl. P.T.), **£3 19 4**.

EX-GOVT. POTENTIOMETERS

Value	Track	Wattage	Spindle length	Price
50Ω	W.W	5	Preset	2.6
100Ω	W.W	1	Preset	1.9
500Ω	W.W	1	5/16in.	1.9
1kΩ	W.W	3	¼in.	2.6
1kΩ	W.W	5	¼in.	2.6
2kΩ	W.W	3	Preset	1.9
2kΩ	W.W	6	"	2.6
2kΩ	W.W	6	¼in.	3.-
3kΩ	W.W	5	Preset	2.6
3kΩ	Carbon Trop.	2	¼in.	1.9
5kΩ	W.W	1	Preset	1.9
5kΩ	W.W	2	¼in.	2.6
5kΩ	W.W	5	¼in.	3.-
5kΩ	W.W	5	¼in.	3.-
7kΩ	W.W	5	¼in.	2.6
10kΩ	W.W	4	¼in.	2.6
10kΩ	Carbon Trop.	2	¼in.	2.-
10kΩ	Carbon	1	Preset	1.3
20kΩ	W.W	3	Preset	2.-
20kΩ	W.W	5	¼in.	3.-
20kΩ	Carbon Trop.	2	¼in.	1.9
50kΩ	W.W (earthed slider)	3	¼in.	2.6
50kΩ	Carbon Mini.	½	¼in.	1.6
100kΩ	Carbon Mini.	½	¼in.	1.6
200kΩ	Carbon	1	¼in.	1.9
500kΩ	Carbon Trop.	2	¼in.	1.6
500kΩ	Carbon Trop.	2	¼in.	1.9
500kΩ	Carbon Mini	½	¼in.	1.6
1MΩ	Carbon	1	¼in.	2.-

All new and unused. Spindle diameter ¼in. in all cases. Quantity prices on application.

TELEVISION MAGNIFYING LENS. 9in. clear, **5**- ; 9in. filter, **6**- ; 12in. clear, **7**- ; 12in. filter, **8**- . Carriage and packing 5- each all types.

BLOWER MOTORS. American make. Nominal input 27 v. D.C. Shunt wound, with field and armature windings brought out separately, so can be put in series for higher voltages. Will also work on A.C., **12 6** each. Tested ex-equipment.

ROTARY SELECTOR SWITCHES. Type 10D/373-374. Sometimes described as impulse relays. 24 v. Solenoid. 52 pulses for one rev. Four position. Single stroke or continuous operation. Platinum contacts. **3**- each, or **15**- per half-dozen.

STABILIVOLT TYPE VS68. Similar to STV280/40. Operating voltages 280, 210, 140, 70 v. Max. electrode current 60 mA. **7 6** each, or **78**- per doz.

METAL RECTIFIERS. Type RM2, 125 v., at 100 mA. Two in series required for mains voltage. Price **4**- each; 6 v. 1 a. half-wave (or full wave with C.T. transformer), price **5**- each; 12 v. 1 a. bridge, **8 6** each.

AMPLION TESTMETER: 10 Ranges A.C. and D.C. Up to 500 v. A.C. and D.C. Resistance up to 200,000 ohms, 1,000 ohms per volt A.C. and D.C. Price **£5**.

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R1155 POWER PACK AND OUTPUT STAGE. Enables this receiver to be operated direct from A.C. mains. Just plug in and connect low impedance speaker. (Note: Speaker not supplied). **£4/10/-**, carriage paid. This unit is manufactured by ourselves from new components and valves, and assembled in a neat black A.M. case, size 8½in. x 6½in. x 4in. All the necessary leads and plugs are supplied and included in the price. Please note the price increase.

COMMAND RECEIVERS. We have two types of these well-known sets, one covers the Top Band, 1.5-3 Mc/s (100-200 metres) and the other 6-9 Mc/s (33-50 metres). Both these receivers are in brand new condition and contained in black crackle cases. Complete with six valves and circuit diagram, less dynomotor at **£4/10/-**, carriage paid.

ERSKINE 'SCOPE MODEL 1A. These 'scopes are complete with tube and valves and ready for operation on 200-250 v. A.C. mains. As advertised previously but in a smaller black metal case, size 8½in. x 6in. x 4½in. All brand new and boxed, an extremely convenient size for the service engineer, experimenter, etc. Full details supplied on receipt of s.a.e. Scope can be demonstrated to callers. Price only **£10/10/-**, plus 5/- carriage and packing.

45 Mc/s "PYE" STRIP. A ready made vision receiver for London frequency. Uses 6 EF50 and an EA50. Circuit data provided. Less valves **37/6**, with all valves, **57/6**, plus 1/6 post and packing.

BATTERY CHARGERS. Contained in black crackle case, size 6in. x 7in. x 12in., includes a heavy duty transformer, metal rectifier, 0-5 ammeter on/off mains switch and 2 Slydlock fuses. 230 volts 50 cycles input, output 4 amp. 6 or 12 volt battery. The transformer, etc., is conservatively rated and the whole unit is of sturdy construction and super quality. Made to a very stringent specification, this equipment is well worth the price of **£4/19/6**, plus 5/- carriage and packing. In brand new unused condition.

MAINS TRANSFORMERS. Three types, all standard primaries. Universal mounting. (1) 350-0-350 v. 80 mA, 0-4-6 v. 4 A, 0-4-5 v. 2 A. (2) 250-0-250 v. 80 mA, 0-4-6 v. 4 A, 0-4-5 v. 2 A. (3) 30 v. 2 A tapped at 3 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v. All these transformers are brand new and boxed, fully guaranteed and priced at **18/6**, plus 9d. post.

SPECIAL OFFER. Manufacturers surplus transformers—standard tapped primary. 375-0-375 v. 200 mA, 6.3 v. 8 A, 5 v. 3 A, 4 v. 2 A, 4 v. 2 A. Size 4½in. x 4½in. x 5in. Semi-shrouded drop through type. A bargain offer at **39/6**, plus 1/6, post and packing.

ELECTROLYTIC CONDENSERS. 16 mF 350 v. working, metal can type, well known make—type CE26L. Brand new at 4 for **10/6**, post paid. Minimum quantity is four. 12-12 mF 350 v. working, type CE34LF, small tubular ally. can type at 3 for **10/6**, post paid. Minimum quantity is three.

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METAL RECTIFIERS. 12 v. 2 A full wave bridge, **12/6**, plus 6d. post. Miniature H.T. rectifiers, type RM2—125 v. 100 mA at **4/3** each, or 2 for **8/-**. RM3—125 v. 120 mA at **5/-** each, or 2 for **9/6**, plus 6d. post on one or two. Selenium rectifiers 150 v. 40 mA at 3 for **10/-**, post paid. 230 v. 60 mA at 2 for **9/-**, post paid. 12 v. 5 amp full wave bridge rectifier at **17/6**, plus 6d. post.

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SPECIAL PURPOSE VALVES VT501 (TT11), 5/-, 954, **2/6**, VR136 (EF54), **6/6**, E1148, **2/6**, VR65a (SP41), **3/-**, VU134 (HVR2), **7/6**. Hundreds of other types in stock. Post 6d. extra for 1 to 4 valves.

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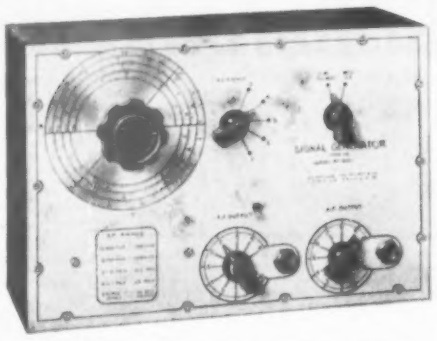

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TRAIN TRANSFORMER. 200/240 v. input, output 30 v. 2 a., tapped 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v., **19/6** (postage 1/6).

EHT TRANSFORMER, for VCR97 tube, with 4 v. for tube heater, and 4 v., tapped 2 v. for EHT rectifier, **37/6** (postage 1/6).

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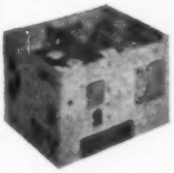
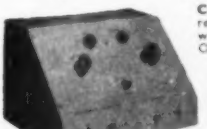


G.E.C. Ex-GOVT. TRANSMITTER RECEIVER. M.R. series. 10 valves, 1 Det. 19, 1 L63, 1 H63, 1 D63, 3 KTW63, 1 KT63, 2 EF50 (value of valves exceeds £10 at current prices), 2 westectors, etc. Grey enamel case size 10 x 8 x 7in., weight 22 lbs. All valves guaranteed. Operating frequency around 90 mcs. We regret we have no precise technical data on this instrument. Apparently designed for mobile work with crystal control (no crystals included). An outstanding bargain at **£3 19 6**, plus 5/- packing and carriage. Condition as new.



CONTROL UNIT. Ex-R.A.F. type 88a, ref. 10L/37. Brand new. Mahogany case with sloping grey enamel panel size 12 x 7in. Overall size of case: base, 12 x 9in.; top, 12 x 4in.; height, 7¼in. Fittings include red and green calling lights, R.T./W.T. switch, send/receive switch, sidetone control, 1 mike, 2 telephone and 1 key jack sockets. Interior chassis size L. 11in., W. 8in., D. 1¼in. Components include VT20 (22OP) valve, 3 L.F. transformers, various first-grade resistors and condensers, outlet cable of 10-way ¼in. screened lead (detachable), terminating in 10-way Jones plug, 2 additional outlets terminating 1 with miniature 2-pin socket and 1 with standard jack plug. A magnificent control unit for your amateur radio station. Price while they last, **25**/- each, carr. paid.

G.E.C. TRANSMITTER RECEIVER, with power pack. Same specification as M.R. series illustrated on this page with the addition of A.C. power pack. This incorporates heavy-duty mains transformer and choke, 5u4G rectifier valve, smoothing condensers, circuit breaker, 6in. P.M. speaker, H.T. switch, mains switch, jewel light, output attenuator. Front panel size 19 x 8in., grey enamel finish. Front to back width, 12¼in.; weight, 60 lbs. First-class condition. Bargain price **6 gns.**, plus part packing and carriage 12/6.

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SECTIONAL AERIAL MASTS. Approx. 30ft. Seasoned timber. 10 metal sleeved sections. Store soiled but absolutely sound. **30**/- each, carr. 5/-. Last few.

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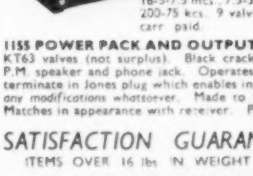

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1155 POWER PACK AND OUTPUT STAGE, complete with U50 and KT63 valves (not surplus). Black crackle case 12 x 8 x 5in., built-in 5in. P.M. speaker and phone jack. Operates on 200/250 v. A.C. Connections terminate in Jones plug which enables instant operation of receiver *without any modifications whatsoever*. Made to "Wireless World" specification. Matches in appearance with receiver. Price **£6 10**/-, plus carriage 3/6.

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TWIN RIBBON FEEDER. Heavy duty 300 ohm., **5d.** per yd. Standard K25 300 ohm ribbon, **9d.** per yd. Co-ax. cable, ¼in. dia. 50 ohm., **8d.** per yd. ½in. dia., 1/3 per yd. 7ft. length ½in. dia. Co-ax. with Pye plug one end, **1/6**, post free. All other Co-ax., and feeder, plus 1/6 post, any length.
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TRANSMITTING TUBES. Type 807, **10/-** ea Type 813 New and Boxed **£3/10** each. 723 A/B Klystron **£3** ea. Type 866A, **17/6** each. Few only.
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WARNING

Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturers' guarantee. Many of these components will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

NEW RECEIVERS AND AMPLIFIERS

UNIVERSAL ELECTRONIC PRODUCTS, 36, Marylebone High St., London, W.1. Welbeck 4058.

SPECIALISTS in the design and manufacture of high fidelity reproducing equipment from 5-100 watts for domestic or industrial purposes. Our new twin channel amplifier (type U.E.57), with independent bass and treble outputs, provides the most satisfying standard of reproduction we have yet experienced. It is now being demonstrated in our showrooms daily (we close Thursday 1 p.m., Saturday 4.30 p.m.), and we invite those who seek perfection from recorded music to hear this superb instrument. We also offer tuning units or complete chassis designed and constructed to individual requirements.

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tomswald, Norwich. [0065

MIDLAND RADIO COIL PRODUCTS offer a service for the production of high quality amplifiers and radio equipment to specification; list of standard products is available; suppliers of audio and radio equipment to the Northamptonshire Education Authority.—Enquiries to 28, Winstanly Rd., Wellingborough. [6536

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Husert St., Birmingham, 6 (Aston Cross 2440), the Midlands specialist manufacturers of high fidelity sound reproduction equipment, for the world-famous Williamson amplifier and associated accessories including "one control" stages, loudspeaker crossover units, distortionless contrast expanders and radio feeders; send for details and prices. [3105

TELRAD ELECTRONICS, 70, Church Rd., Upper Norwood, London, S.E.19.—Designers and manufacturers of Telrad quality amplifiers; established as the most outstanding value in high-quality amplifiers, thanks to faithful reproduction at unrivalled price, these unique amplifiers are the first choice of the enthusiast; built to satisfy the discriminating ear; bass and treble independent controls, providing widest possible variation to suit all recordings and varying acoustic properties of one room with another; full details on request.—Write, call or 'phone Livingstone 4879.

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

LOWTHER D.T.4 tuner unit; £22.—Main, The Cottage, Dulverton, Som. [7872

ARMSTRONG chassis, R.F.105/5, matched speaker, as new; £22/10.—37, Hurst Rd., Hinckley. [7859

BC-342-N receiver, in perfect condition.—Offers to W. C. Parker, 22, Castle Gardens, Dorking, Surrey. [7768

S.M.W. superhet chassis, 39/6; 8in speakers, 10/6; particulars s.a.e.—Curtis, 26, East Dulwich Rd., London, S.E.22. [7761

QUALITY amplifier and triple cone speaker, both by Baker Selhurst; nearest £18.—Tel. Horley 1566 after 7 p.m. Box 3523. [7860

BC-454, few only to clear, 35/-; 28v p'ug on dynomotor for above, 17/6; both carriage paid.—Clarks, 103, High St., Sandown, I.W. [7841

AC, 15watt amplifiers, £10; 12v amplifiers, 10watt, £8; 25watt, £12; 30watt, £16; all less cabinets, like new.—Radiovox Sound System, 5, Oxford Place, Leeds. [7697

VORTEXION CP20A amplifier, Lustraphone M.C. mic. and 5ft adj. stand; Vitavox carmtg. 3-coll. horn and GP1 pressure unit, all postwar, perfect, little used; £48.—Sk.pp, Baldock Rd., Buntingford, Herts. [7762

VIEW-MASTER 12in console receiver, complete with tube, valves and commercially built cabinet, in working condition, approximately 9 months old. £29/10.—Weir, Ewell House Parade, Ewell. Ewell 5404. [7750

EXPERIMENTER'S surplus: Command Rcvrs. BC454, BC455 unused; 10-way push-button units with 6 pre-set coils, escutcheon, buttons, circuit.—I.F. 465 K.cs, 21/-; Denco DCA2 deflector coils, 50/-; FMAI P.M. focus unit, 25/-; LHT1 line O.P., tHT unit with 2 EY51 valves, £4/15; Vortexion AC20 amplifier, £12; all carr. paid.—J. Henderson, 99, Eastern Ave., Largs, Ayrshire. [7738

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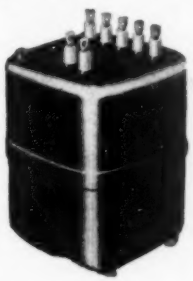

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RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx's and units in stock, also AR88, BC348R, CR100 etc.—Requirements please to R.T. & I. Service, 254, Grove Green Rd., London E.11. Let 4986. [0055

HOWARD 450A receiver, 12 tube, 4½ to 550 metres, matching speaker, excellent condition, bandspread, S meter, crystal, £40. Admiralty R50, built-in power pack, £10; 1224, 50/-.—Hough, 118, Gainsborough Rd., Crewe. [7786

WILLIAMSON amplifier (Partridge transformers) pre-amp and tone control, T.R.F. radio receiver, Barker 148A speaker in reflex cabinet, Acos GP20 pick-up with 2 heads, Garrard motor 33⅓-78, all unused; £40.—Tel. Edgware 1548. [7729

FOR sale, Vortexion amplifier in duplicate complete with two exciter lamp rectifier units and gram turntable with three Rola p.m. speakers, 40 spare valves for use with above amplifiers, £25 the lot for quick sale.—Willson, Rutland Cinema, Uppingham. (Tel. 5125.) [7855

CONNOISSEUR S feeder unit, as advt. in "W.W." classified advts., 9-1,500m, 7-valve 8 het, switchable to first-class TRF or gram, BFO, vernier logging scale, bass and treble lift and cut, perfect, very good, very smart; £15.—Boys, Dane Court, Pyrford, Woking, Surrey. [7751

LOUDSPEAKERS—SURPLUS AND SECONDHAND

A.D.C. 15in loudspeaker (see "W.W." Dec., 1951, p. 651); brand new demonstration model £15/15; carr. paid (retail price £18/18). PHASE-IN SPEAKERS, 99, Ash Bank, Bucknall, Stoke-on-Trent. [7686

VITAVOX, K12/20, 15 ohm, 20 watts, superb, £5.—Write or call evening, Holloway, 8, Carlingford Rd., Hampstead, London, N.W.3. [7834

VOIGT domestic corner horn, overmantel and veneered English walnut with Lowther P.M.2 unit, all in new condition; cost £102; offers.—Tel. Hindhead 125. [7910

P.A. 50in re-entrant metal horn speakers, 10watt 6.5ohms, 90/-; P/A 30in straight metal horns, 35/-, like new.—Radiovox Sound System, 5, Oxford Place, Leeds, 1. [7898

FOR Sale: Small stock of 2 a radio engineer, including loudspeakers, transformers, etc.; appointment to view, apply—H. G. Mullard, 21, St. Helen's Estate, Abingdon, Berks. [7688

EXPERIMENTER'S surplus.—Vitavox K12/20 in polished hardwood cabinet £8; Brierley rubber armature pick-up and matching transformer £5.—6, Gainsborough Gardens, Edgware. Tel. Edg. 6065. [7664

VITAVOX pressure unit G.P.1 with 3-cell exponential horn, 220 series, £16; Goodmans 15in bass speaker, £15; Garrard induction type gram. motor, Soundsales non-magnetic turntable, Connoisseur pick-up, £9 complete.—24, Devon Rd., Blythe Rd., W.14. [7833

WHARFEDALE Super 5CSAL speaker in cabinet, as new, in original carton, 75/-; Wharfedale crossover unit for above, 42/-; Wharfedale choke volume controls, 25/-; all as brand new; modern walnut radiogram cabinet, 53×18×38, excellent condition, £10.—Box 5561. [7695

NEW TEST EQUIPMENT

TOROIDAL coted coils—offer optimum performance at all frequencies. Technical advice offered.
BEL SOUND PRODUCTS, Co., Marlborough Yard, London, N.19. Arc. 5078. [0186

FOR sale, brand new Taylor meters, model 75A multi range 30A oscilloscope, 65C and 45AP meters, also 47AS valve tester.
F. W. KUBACH, 12, Sylvan Rd., Upper Norwood, London, S.E.19. Tel. Liv. 3511-2. [7740

TEST EQUIPMENT—SURPLUS AND SECONDHAND

SIMPSON, model 260, £15/10, new and unused.
R.C.A. voltohmyst, £25; new and unused.
A.V.O. valve characteristic meter, £30, new condition.
TWO A.V.O. model 40, £7 each, very good condition.
TRIPLET signal generator, £27, new condition.
E.S.—5, Gloucester Ave., Slough, Bucks. [7800

TAYLOR 65B signal generator, little used, £10.—Sk.pp, Baldock Rd., Buntingford, Herts. [7763

SIGNAL generator, Homdab, guaranteed perfect, cash offers.—Hobley, 109, Drive, Wellingborough. [7780

COSSOR 339 D.B. oscilloscope almost unused, perfect as new; £40.—Radio Acoustics, 181, Dalston Lane, E.8. [7760

EVERSHED 500v bridge megger as new (maker's overhaul); £25 or near offer.—Tunstall, Rectory, Stittingbourne. [7775

TAYLOR model 85A, 90 ranges, 20,000 o.p.v. and 10 kV multiplier; condition as new; £14.—Jones, 9, Chesney Ave., Chadderton, Lancs. [7819

UNIVERSAL avometer, model 7 with leads, in case, £12/10; universal Avo Minor, £6 both as brand new.—Linton, The Tile House, Cherry Tree Rd., Farnham Common, Bucks. [7812

HITTING THE HI-SPOTS IN NEW YORK

During November we demonstrated Hartley-Turner reproduction at the New York Audio Fair. We were the only British manufacturer there with our own exhibit, but every American speaker, amplifier and pickup worthy of the name was present to be heard by musicians and high-fidelity experts under conditions entirely favourable to each exhibitor. Each exhibitor (if he had the sense to realise it) could demonstrate his equipment so that the customer could hear what it would sound like *at home*.

Our visit was an unparalleled success. We had no idea what modern American equipment sounds like, no idea of what we were up against. Now we find we have nothing to worry about. The Hartley-Turner 215 speaker sells in the U.S.A. at $54 (while others sell at prices up to $650) but *literally* hundreds of people told us that we were putting up by far the best show at the Fair.

From the moment the show opened, our demonstration room was packed with music-lovers who came, sat and wondered how on earth it was done at all, and how in heaven it could be done for $54. At least three manufacturers of vast, multiple-unit speakers listened to our little 215 and said "You have a wonderful, an amazing job there. How is it done?"

The answer is quite simple. The 215 is the logical outcome of 24 years of development of a speaker primarily designed to satisfy musicians, and what we have achieved is good enough for everyone who knows what live music sounds like. And the price in Britain is £10 10s. 0d. (plus 5s. for postage, packing and insurance when not collected by hand).

Full details will be sent free on request.

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152 HAMMERSMITH ROAD, LONDON, W.6
Phone: RIV. 7187

TEST EQUIPMENT SURPLUS AND SECONDHAND

COSSOR double beam oscilloscope 339A, in perfect condition.—Offers to W. C. Parker, 22, Cattle Gardens, Dorking, Surrey. [7767

AMATEUR selling equipment at bargain prices, a.c. wavemeter, oscilloscopes, signal generators, receivers, etc.; send stamped addressed envelope for list.—Gilford, 22, Pembury Rd., Tonbridge. [7915

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock, your enquiries are invited.—Requirements to R.T. & I. Service, 254, Green End Rd., London, E.11. Ley. 4986.

AVO 40, as new, £10; industrial electronics Model 1200 100 mc/s, as brand new, £20; BPL wobbulator RS800, as new, £8; Mullard universal bridge, as new, £6/10; Avo valve tester with roller panel and two spare panels, as new, £12/10.—Progress Radio, 46, Roman Way, London, N.7. [7915

TAYLOR signal generator, just overhauled, £6/10; T.V. pattern generator, 50-100 mcs, as new, £10; 10 m/c crystals, 100 kcs, 12/6 each; 0-1ma meters, 3½ type Ferranti and Weston, as new, 15/-; Bu.a.n red panel lamps, 1/9; Octa. valveholders, ampheno, type, 5d.; send for list.—Wallis, 7, Postley Rd., Maidstone, Kent. [7769

COSSOR 339 oscilloscope 343 Wobbulator, £55 the two; BC221 frequency meter (modulated), complete with mains unit, service manual, etc., new, one only, £40; callers preferred, Tinsley's condenser microphone tester, VHF receiver R1294, 500-3,000mc/s, as new, with manual, £15.—Haynsons, 14, St. Mary's, Bedford. Tel. 5568. [7854

AVO test equipment, little used: Oscillator, a.c., £11/10; model 40, £8; model 7, in case, £12/10; valve tester, £12/10; also 50watt bass speaker, £7/10.—Sound Sales, mike, £3; MSS line recorder, in case, £50; Woden 60watt amplifier, unused, £25; 0-25 microammeters, 25/-; wanted, electronic avometer.—Johnson Claylake, Endon, Stoke-on-Trent. [7880

NEW DYNAMOS, MOTORS, ETC.

BATTERY chargers, 2-6-12volts, 1amp., a.c. mains operated, ammeter fitted, guaranteed, 52/6 (despatch 2/6).—Thames Valley Products, W.2, 28, Camden Ave., Feltham. [7854

BATTERY chargers, 4 models, 2-6-12v, 1-2-4 amp D.C.; any mains voltage; also larger types special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Boddenden, Herts. [0122

A LL types of rotating electrical machinery up to 20kva available, including rotary converter, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are also in a position to quote for power transformers, as actual manufacturers we will be glad to quote for any quantity for home or export.—DIESEL Electric generating plants, 5kva, 230v with push-button remote control, starting equipment, ready for use, £250.

ROTARY transformers, input 20v d.c., outputs 6.5v d.c. and 500v d.c., permanent magnet field, 20/-; ditto, input 28v d.c. and 1,200v 70ma d.c. output; energised field, 35/-; ditto, input 12v d.c., output 500v, 90ma d.c., energised fields 35/-; reasonable delivery.—CHAS. F. WARD, Lordscroft Works, Haverhill, Suffolk. Tel. 253. [0039

DYNAMOS, MOTORS, ETC., SURPLUS AND SECONDHAND

PLEASE see "W.W." Nov. page 92; only the following items supplied in January.

NEW model diesel alternator plant, on steel frame, 230/1-50, plus 32v 15a d.c. Petters latest. Avail. air cooled diesel engine, belt driven alternator, self-generated, automatic voltage control by winding on stator, at govern. speed 1,500 r.p.m., d.c. output, trickle charges, starter battery, or charges up to 15amps, when starter battery is also used for lighting, when main plant is not in use, start and stop by remote control press-buttons, complete with main switch and fuses, battery cables, filled and charged, 24v 75amp h. batt., when required, massive concrete bed with bolts, wt. over 10cwt, engine covered by Petters inspection service, £250, free delivery 100mls., London, where remote start and stop not required, only press start on plant, reduction of £6, a few from stock, others quick delivery.

ALTERNATORS type as fitted in above plant, 110/1-60 or 230/1-50 6kva, £64 delivered, also 110/1-60 or 230/1-50 6kva, £85 del.; 8kva £69, 6 kva £91/10, f.o.b. London docks, speed 50 cycles 1,500 rpm, 60 cycles 1,800 rpm, all four alternators self-energised, self-start, automatic voltage regulation, separate 32v 15a d.c. for charging starter battery, 24v lighting when alternator is not in use, kindly state direction of rotation at pulley end; owing to many enquiries for small alternator of this type, will soon list an alternator of very robust construction, 1.5kva 230/1/50 plus 12v charging and starting, enquiries please; the above are not surplus, but current products of British manufacture.

6v BATTS., 100-125amp/hr, £5 del.; rotary converters 24v d.c. to 230/1/50, 80-100 watts, switch, meta, £5/17/6 del.; shunt dyno., 32v 9a £6/5; used but good 90/- del.; sliding res. Zenith 2Ω 16a, 5Ω 10a, 19/6 del.; Westinghouse electric vehicle battery charger 230-250/1/50 in, charges 40 cells 30a, slow and fast charge, fitted adjustable automatic time control, switches off when charged, also choke control, selenium rects., size 4ft h., 2ft 4in w., 2ft 5in d., wt. over 5cwt, £70, carr. extra, smaller 12 and 24v chargers, see "W.W.," August, p.74.

PLEASE see displayed advert. page 90, for S.T.C. selenium rectifiers; terms c.w.o., pro forma invoice, c.o.d. (post, good only).—T. W. PEARCE, 66, Great Percy St., W.C.1. (near Angel). [0014

MAGNETIC TAPE
Recording equipments and Components

MAGNETIC HEADS. A new series of ¼-track totally enclosed heads are now offered having a wide frequency range and high efficiency. These heads are considered the best available today. The frequency response obtainable is better than 1 kc/s per inch of tape speed with simple correction equipment. Consistency is maintained by employing optical finishing techniques.

RECORD/REPRODUCE HEAD. Employs the smallest effective gap obtainable. Available in low impedance (2.4 mH, 15 ohms at 1 kc, approx.), and high impedance (200 mH, 1,250 ohms at 1 kc, approx.). **Price £3/3/-.**

ERASE HEAD. Available in medium impedance. **Price £3/-/-.**

TRANSFORMER. Suitable for low-impedance head to grid step-up. **Price £1/-/-.**

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OSCILLATOR COIL ASSEMBLY. Comprises high-"Q" coil and condenser tuned to 45 kcs. Specially designed to provide highly symmetrical sine wave output for low tape noise. **Price 10/6.**

OSCILLATOR UNIT. Constructed on small chassis suitable for sub-assembly, provides r.f. for erase and bias at 45 kcs. Requires 250 v. h.t. and 6.3 v. for operation. Complete with 6V6 valve. **Price £3/-/-.**

AMPLIFIERS. A range of amplifiers have been developed specifically for use with tape. Please send for further details.

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Electronic Equipment Manufacturers
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Sound Panel Chassis Assembly, fitted with Screens, valve-holders, formers and dust cores.
Vision Panel Chassis Assembly, fitted with screens, valve-holders, formers and dust cores.
9in. and 12in. C.R. Tube Support for mounting on top of Gantry assembly.
Smoothing Choke (Ch. 9) 5 H., 250 m/A.
5-valve Superhet Radio Chassis. Drilled and fitted with 5 Amphenol Octal valve holders, aerial, earth and gramophone sockets, necessary cut-outs for all control mountings, mains transformer and tuning gang condenser. Complete with 2 steel fixing feet. Cadmium plated.
Full Vision Drive Assembly. Fitted with unbreakable Perspex 3-coloured scale for long, medium and short wave-bands. Calibrated in metres, kilocycles and station names.
I.F. Transformers High Q 465 k/cs.

ALBERT MANUFACTURING CO.
5 SHAKESPEARE ROAD, FINCHLEY, N.3
Telephone: FINchley 2188

DYNAMOS, MOTORS, ETC., SURPLUS AND SECONDHAND

PIONEER Gene-motors, 50v/250v 50ma, soiled; 7/6 ea.; post 1/6.—Champion, 43, Uplands Way, London, N.21. Lab. 4457. [0171

TRANSMITTING EQUIPMENT

MAGSLIP transmitters from 10/-; ideal for remote control of radio apparatus, including Antenna direction indication; stamp for details.
ENGINEERING FACILITIES LTD., 29, Rea St., Birmingham, 5. [7507

RACK built 50watt phone and c.w. transmitter, quality job; Eddystone 640 receiver, as new; power pack 1,000 volts, new; various Woden transformers, as new; offers.—Graham Newbery, Axminster. [7815

A LARGE quantity of transmitters and transmitter-receivers available for export only; types TR1143A, TR5151, BC375E, SRC695A, BC6690, T3040, T5065B, T1406B, T1151, T3501, E1087, T1090, T1153H, T1154B. Also motor-alternators for GEE, output 80v, 25 amps, 1,500 cycles.—Write E. & W.S. Co., 69, Church Rd., Moseley, Birmingham. [7755

VALVES

VALVES.—Large stock of non-current type valves at original prices; 24-hour service.—W. WATERS & SONS, Ltd., 32, Great North Rd., Hatfield, Herts. Tel. Hatfield 2855. [7902

NEW GRAMOPHONE AND SOUND EQUIPMENT

FRITH RADIOCRAFT Ltd., offer from stock:—
SCOPHONY-BAIRD magnetic tape recorders, complete in luxury portable case with m/c mike, £58/5/6.
EDDYSTONE communication receivers; 740 £38.15.0, 750 £68.
PHILIPS 12-volt Motoradio model 574V, three only, at pre-budget price £29/6/4.
PULLIN series 100 multirange meters, 10,000 ohms per volt, 21 ranges; £11.11.0.
SKYWAY "Junior" amplifiers, 2×EL32 push-pull output, high impedance PU input only; £8/15.
SKYWAY "Baby Grand" amplifiers, 2×6V6 push-pull output, de luxe type with Woden "Potted" transformers, treble and bass controls, inputs for 50 and 500 mV; £14/14.
RECORDING tape EMI 65A, 65B or H60, 55/-; Scotch Boy (Durex), 35/-; Philips, £2; all 1,200ft reels; spare reels, 4/-.
RECORDING motors BSR SR1, 52/-; SR2, 25/-; FP10, 58/-; Collaro clockwise or anticlockwise, 42/-.
WHARFEDALE "Golden" 10in speakers, 3 or 15 ohms; £5.2.6.
W.B. SPEAKERS, 9in PM, "Stentorian," 3 ohms, £1/16/9; 10in P.M., £2/4/6.
CELESTION speakers, 12in PM, 5 ohms; £4/5.
ACOS microphones, MIC 22/1 or 22/2, for floor or desk stand fitting, £6/6; table stands, 21/-; 3-section folding floor stands, £5/7/6.
COLLARO RC500 auto changers, 78 r.p.m., play ten 10in or 12in records unmixed, lightweight p.u. for "99" needles; £11/16/9.
EKCO moulded plastic speaker grille, 16½in×12in, cream or gold, entirely free from resonance, 6/6 plus 1/3 post; sample on request.
ESCUTCHEON moulding flexible cream plastic, ¼in U section, 1/6 per yard.
NEW type and scarce valves, EF37A 25/2, PZ30 21/6, UU8 21/6, ECL80 26/8.
FRITH RADIOCRAFT, Ltd., 69-71, Church Gate, Leicester. Tel. 58927. [0024

QUALITY portable amplifier, twin turntables, spkr., all oak cased, one for sale at £65, or nearest.
BEL SOUND PRODUCTS, Co., Marlborough Yard, London, N.19. Arc. 5075. [0187

TAPE recorder motors, 250v a.c., powerful, quiet brand new, 13/11; post, etc., 1/1.—K. W. Logan, Westalley, Hitchin, Herts. [6469

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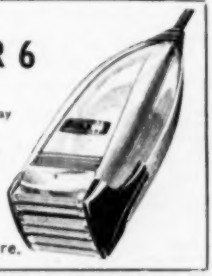

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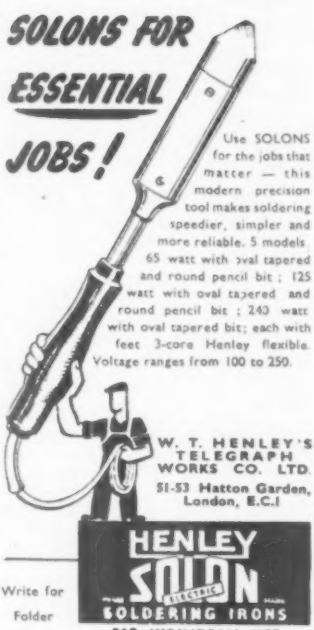

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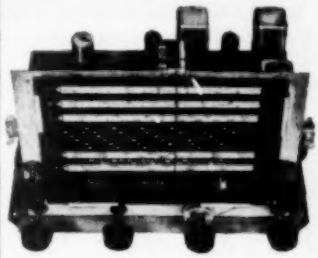

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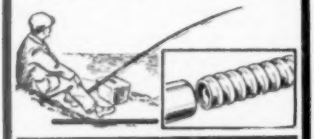

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S. Lord, Secretary. 17684

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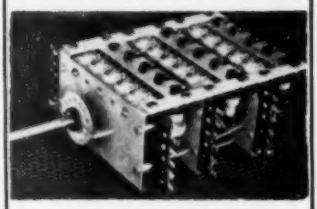

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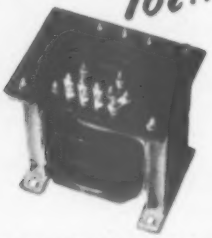

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LABORATORY assistant with experience in electronics and/or electrical instrument calibration, required for work of an interesting and varied nature in connection with instrumentation for aircraft engine flight development and allied projects.—Apply giving details of experience, salary required, etc., to Box 5136, quoting Ref. G.11. [7795

BANGKOK.—Merchant company requires as commercial assistant a radio engineer with good training and general experience, age about 24; salary according to experience, plus cost-of-living allowance, free unfurnished accommodation, Provident Fund pension scheme, etc.—Apply Staff Secretary, Borneo Co., Ltd., 143-9, Fenchurch St., E.C.3. [7795

A LABORATORY assistant required, capable of taking charge of electrical and electronic equipment for a guided missiles project; duties will include calibration and minor repairs of instruments; applicant with the necessary experience will also control sub-standard room and undertake design of laboratory equipment.—Full particulars to Box 4521. [7539

ROCKET motor design and development.—Physicists and electrical or electronic engineers required for work on testing and instrumentation in this new and rapidly expanding field, on a project connected with the guided missile programme; location near large industrial town in Midlands.—Applications to Staff Officer, Box 5136. [7799

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ALWYN ISHERWOOD, Ltd., require T.V. engineers for bench and field service. If you want good pay with prospects under ideal operating conditions, and you are master of your craft, contact the Service Manager, Alwyn Isherwood, Ltd., 215/5, Westgate, Wakefield. Tel. 5196/7. Expenses will be paid for all applicants selected for interview. [7817

INDUSTRIAL Research.—Applications invited from physicists or electrical engineers for position of senior development engineer to London company manufacturing capacitors; good degree and some research experience will be required; good salary with pension rights for first-class man.—Write, giving full details of age and experience, to Box 5408. [7844

ELECTRONIC engineer, with good theoretical background to Higher National Certificate standard and with practical experience in use of valves in audio and radio frequency circuits, is required in the valve life testing laboratory at the G.E.C. Research Laboratories, Wembley, Middlesex. Apply to the Staff Manager (Ref. GBLC/0.265), stating age and record. [7791

JUNIOR engineer required for high-priority electronic and light mechanical work in equipment laboratory of Surrey factory; previous experience is essential, and technical training to Higher National Certificate is desirable; salary according to experience and qualifications; staff pension scheme in operation.—Write, giving full details to Box 5409. [7847

SENIOR engineer required to undertake development work on low-frequency iron-cored components. Previous experience in this subject is essential, and a degree or equivalent would be an advantage. The salary will be in accordance with qualifications and experience.—Apply in writing to Advance Components, Ltd., Back Rd., Shernhall St., Walthamstow, E.17.

HIGH power rf dielectric heating equipment.—Engineer required to supervise installation and acceptance tests; experience on either large rf heating equipments or radio transmitters employing water-cooled valves is essential; this position has particularly interesting prospects; write, stating full experience, age and salary required.—Radio Heaters, Ltd., Wokingham.

LARGE manufacturer's service organization requires additional engineers for home service work, in all parts of Great Britain; technical ability, practical experience, and a clean driving licence essential; van, test equipment and tools provided; payment by salary, bonus, expenses and commission.—Apply in writing, General Manager, Home Maintenance, Ltd., Langley Park, Slough. [7789

A FEW interesting vacancies exist for graduates in physics or electronic engineering preferably with first- or second-class honours; the work relates to Government Development Contracts connected with frequency control systems.—Apply Personnel Manager, Standard Telephones & Cables Ltd., North Woolwich, E.16, giving summary of experience and qualifications and quoting reference 2371. [7720

SEVERAL vacancies exist in the development laboratory of the General Electric Co., Ltd., Witton, for development engineers in the electronics, electrical machines and protective gear sections; applicants should preferably possess a degree or Higher National Certificate in electrical engineering, but those taking their final examination this year will also be considered; salaries will depend upon qualifications, age and experience.—Apply in writing, giving full particulars and quoting "Development Laboratory," to Staff Manager, General Electric Co., Ltd., Witton, Birmingham, 6." [7691

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ENGLISH ELECTRIC VALVE Co., Ltd., Chelmsford, require an engineer for testing and development work on micro-wave klystrons. Applicants must have degree or equivalent qualification, but previous experience is not essential.—Write giving full details of qualifications and experience, mentioning ref. 419D, to Central Personnel Services, English Electric Co., Ltd., 24-30 Gillingham St., London, S.W.1. (7908

THE ENGLISH ELECTRIC VALVE Co., Ltd., Chelmsford, require a foreman on valve production; men with experience of this type of work with particular reference to micro-wave equipment are invited to apply for this permanent and progressive position.—Write, giving full particulars of qualifications and experience, quoting Ref. 948, to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham St., London, S.W.1. (7846

LABORATORY assistant required for Instrument section; previous experience in making and repairing indicating instruments essential; Higher National Certificate or equivalent qualification would be an advantage, but is not essential.—Apply in writing giving full details of training and experience to the Staff Manager (Ref. GBLC/O/920), Research Laboratories of the General Electric Co., Ltd., East Lane, Wembley, Middx. (7856

ENGLISH ELECTRIC VALVE Co., Ltd., Chelmsford, have vacancies for young engineers to work on radio valve design and development; applicants should be of degree standard, while experience of this type of work is desirable it is not essential and otherwise suitable candidates will be considered.—Write giving full details quoting Ref. 497D to Central Personnel Services, English Electric Co., Ltd., 24-30 Gillingham St., London, S.W.1. (7855

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, requires skilled inspector for mechanical and wiring inspection of prototype equipment in an experimental laboratory, A.I.D. experience an advantage; also required are electrical inspectors for laboratory assistants, for test of above equipment, preferably with Higher National or City and Guilds Certificates.—Apply by letter, stating age and experience, to the Personnel Manager (Ref. RG). (7908

BELLING & LEE Ltd. Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E. or possess equivalent qualifications together with similar laboratory experience; salary will be commensurate with previous experience; applications will be detailed and concise, and will be treated as confidential.

THE TELEGRAPH CONDENSER Co., Ltd., have a vacancy for an engineer with a good degree and industrial experience in research on di-electrics or the manufacture of electrical condensers; the position is of a senior character and is pensionable; commencing salary will be in accordance with age qualifications and experience.—Write, giving full details, to the General Manager, The Telegraph Condenser Co., Ltd., North Acton, London, W.3. (7851

A SENIOR engineer is required by the Industrial Electronics Dept. of the English Electric Co., Ltd. for the design of circuit work on valve-type HF heating generators. Applicants should have good experience in this type of work or on radio transmitters. A University degree is desirable but not essential.—Please write giving full details and quoting ref 557B to Central Personnel Services, English Electric Co., Ltd., 24-30 Gillingham St., London, S.W.1. (7804

EXPERIENCED electronic engineers required for interesting development work on a number of projects; applicants should have a sound theoretical background with several years experience in the design and engineering of prototype electronic equipment; the posts are for permanent staff and offer good salaries and prospects.—Please write giving full details and quoting ED/65, to Personnel Department, E.M.I. Engineering Development, Ltd., Hayes, Middx. (7891

MARCONI'S WIRELESS TELEGRAPH Co., Ltd., have vacancies for technical assistants for contract work in their Broadcasting Division. Applicants should have had works experience, preferably in the planning and progressing of production. Some experience of broadcast or television equipment would be an advantage. Successful candidates will be paid a salary in a grade which rises to a maximum of £515 p.a. A staff pension scheme is in operation. Please write giving full details and quoting Ref. 847B to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham St., London, S.W.1. (7857

ELECTRONIC test engineer required to supervise small test section on interesting design project. Grad. I.E.E. or equivalent standard plus at least two years' practical electronic test and inspection experience, or alternatively at least five years' experience including pulse technique and microwaves are necessary qualifications. Also required a junior for training having basic knowledge and preferably some experience of meter or testgear calibration.—Write giving full details and quoting Ref. 899A to Central Personnel Services, English Electric Co., Ltd., 24-30, Gillingham St., London, S.W.1. (7874

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JUNIOR radio engineer required for installation and testing of aircraft radio equipment; duties will involve test flying; current M.C.A. operator's licence an advantage, but consideration will be given to suitable applicant prepared to obtain licence during probationary period.—Application should be made in writing, giving details of experience and salary required, to the Personnel Manager, The de Havilland Aircraft Co., Ltd., Hatfield. [7600

SENIOR circuit engineer is required by the English Electric Co. for employment in the London area; experience of designing time bases, stabilised power packs and cathode ray monitoring circuits is essential; a degree and an interest in production development is desirable; a good salary will be paid to the right man for this responsible position.—Write, giving full details, quoting ref. 521, to Central Personnel Services, English Electric Co., Ltd., 24/30, Gillingham St., London, S.W.1. [7679

SEVERAL electronic engineers or physicists are required who have graduated in physics or telecommunications and have two or three years' radar experience, to take charge of the development of particular sections of a project involving radar. The work includes design of pulse generators, timing wave form oscillators, electronic computors, V.H.F. transmitters and receivers and servo systems. In addition technical assistants are needed with H.N.C. or equivalent qualifications.

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AN instrument mechanic is required for duties in the Electronics Section of the Research and Experimental Department; applicants should possess a high degree of mechanical skill, and be able to participate intelligently in both design and manufacture of small electro-mechanical device; experience in a similar capacity, whilst desirable, is not essential.—Write, stating age, experience, and salary expected to the Personnel Officer, Saunders-Roe, Ltd., East Cowes, I.O.W. [7824

SENIOR draughtsmen; Metropolitan-Vickers Electrical Co., Ltd., require for their Trafford Park works a number of senior draughtsmen, preferably with experience in radio and radar equipment; for qualified men these jobs are permanent, five-day week under good conditions.—Apply in writing stating age, experience, qualifications, salary required, etc., marking envelopes "Radio D.O." to Personnel Manager, Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, 17. [7424

DRAWING office instructor required, January, 1952; duties consist mainly of instruction in engineering drawing, mathematics and mechanics to draughtsman apprentices; applicants should have served an engineering apprenticeship with subsequent drawing office experience, preferably in light mechanical or electronic engineering; instructional experience is desirable but not essential; salary £525-£625 per annum.—Applications to The Principal, E.M.I. Institutes, 10, Pembridge Sq., London, W.2. [7949

APPLICATIONS are invited by the Ministry of Supply from Electrical engineers and physicists for the following immediate vacancies at a research and development establishment in the South Midlands for work on Army radar equipment, candidates should have experience, or interest, in development and experimental design work in the field of electronics including communications equipment, servo mechanisms and microwave techniques, candidates with the qualifications outlined below are asked to make early applications for the vacancies.

SCIENTIFIC officer class. 1st or 2nd class honours degree or equivalent qualification in physics or electrical engineering, grade and salary will be assessed according to age, qualifications and experience within the following ranges (candidates for the senior posts must have had at least 5 years' post-graduate research experience), principal scientific officer (minimum age 31) £960 to £1,295; senior scientific officer (minimum age 26) £720 to £910; scientific officer £390 to £625; rates for women somewhat lower; posts are unestablished but carry benefits under F.S.S.U. (Ref. No. A566/51/A); experimental officer class, minimum qualification higher school certificate but other qualifications, e.g., higher national certificate or a degree would be an advantage for some of the posts; some experience in industry or a technical branch of the Forces is also desirable; grade and salary will be assessed according to age, qualifications and experience within the following ranges; senior experimental officer (minimum age 35) £742 to £960; experimental officer (minimum age 25) £545 to £695; assistant experimental officer £390 (at age 18) to £505; rates for women somewhat lower; posts are unestablished (Ref. No. D523/51/A).—Application forms obtainable from Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26-28, King Street, London, S.W.1, quoting appropriate reference number; closing date January 14, 1952. [7900

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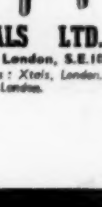

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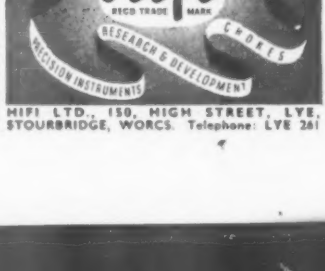

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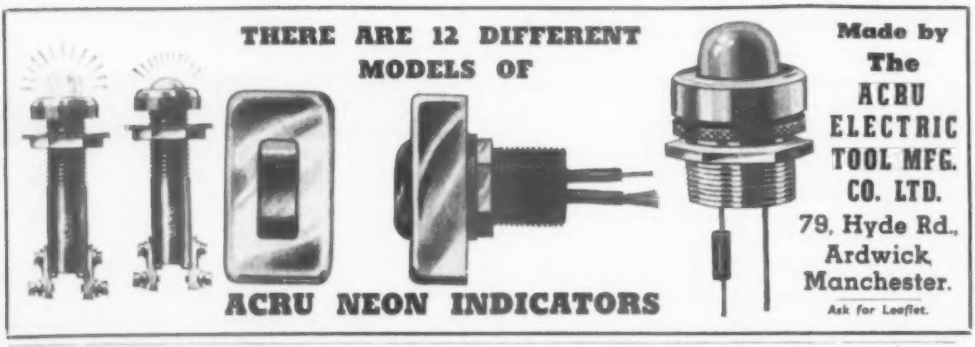
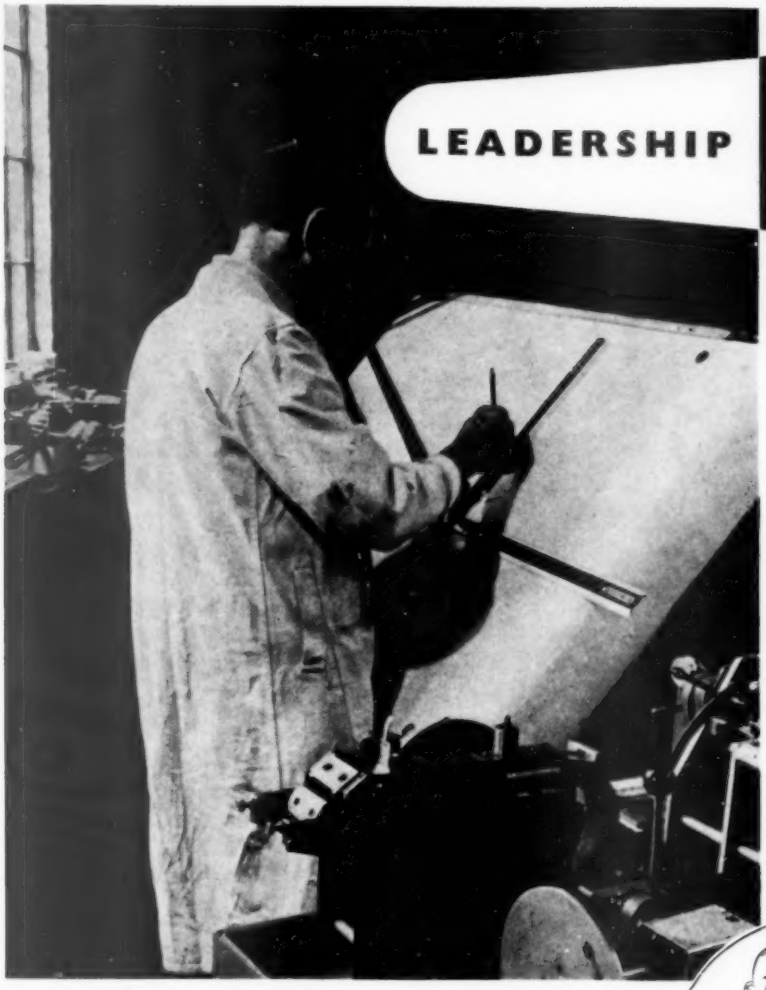


Printed in Great Britain for the Publishers, Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1, by Cornwall Press Ltd., Paris Garden, London, S.E.1. *Wireless World* can be obtained abroad from the following: Australia and New Zealand: Gordon & Gotch, Ltd. India: A. H. Wheeler & Co. Canada: The Wm. Dawson Subscription Service Ltd.; Gordon & Gotch, Ltd. South Africa: Central News Agency, Ltd., William Dawson & Sons (S.A.), Ltd. United States: The International News Co.



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